# AN INVESTIGATION OF THE COGNITIVE CONTROL OF PAIN

A thesis submitted in partial
fulfilment of the requirements
for the Degree of Master of
Arts in Psychology in the
University of Canterbury

by

CAROL MCCRORY

---

University of Canterbury
November, 1979.

# TABLE OF CONTENTS

# LIST OF TABLES

# L I S T O F F I G U R E S

## ACKNOWLEDGEMENTS

I wish to thank Dr M. B. Simmonds in his role as my thesis supervisor and in particular for his assistance with the statistical analysis. My thanks are also due to Ms P. Buttery for proofreading the final copy of this thesis, to Mr G. Lewis for the recording of the videotapes, and to Mr R. Phillips for the production of the photograph.

## ABSTRACT


Recent literature in the area of pain research is reviewed with emphasis on studies examining the effects of the various methods of cognitive control of pain.

An experiment is reported that examines the effects of two cognitive strategies, watching a videotape and backwards counting, on pain induced by the cold pressor technique. The effects of knowledge of aim of the experiment on pain experience is also examined.

A number of dependent variables were recorded and used in the data analysis. Of these only one, the number of comments made by the subjects about the sensations felt in their hands, shows any significant difference when the different conditions are compared. The results of the other data analyses, though non significant do follow the expected direction thus lending some support to the hypotheses that knowledge of aim of the experiment increases tolerance level, and that as the level of distraction increases tolerance level will also increase.

Some reasons for the non significance of the results are discussed and areas for future investigation in pain research are suggested.

# CHAPTER I

## INTRODUCTION AND LITERATURE REVIEW

For many years pain was considered to be a function of physical injury, or tissue damage. Any pain experienced as a consequence of injury was expected to vary in intensity as a function of the severity of the injury. However more recently pain, at least in man, has been regarded as a far more complex phenomenon.

More recent research suggests that pain may have a large psychological component, as well as having a far more complex physiological basis than was previously held. Pain perception is now thought to be affected by a variety of factors, including the individual's physiology and various psychological factors, such as culture, previous experiences of pain, how well these experiences are remembered, and the ability to understand the cause of the pain and its consequences.

One of the best known and most often quoted examples of the psychological component or pain perception is the report of soldiers wounded during combat by Beecher (cited in Melzack, 1973). This study compares their reactions to their wounds with the reactions of civilians to similar injuries resulting from recent major surgery. Beecher observed that many soldiers, often very badly wounded during combat, denied having any pain from their wounds or had so little that they did not want medication to relieve it. Beecher further reported that these men were neither in a state of shock nor unable to feel pain. By contrast, civilians with similar wounds to those of the soldiers complained of pain and requested morphine injections far more frequently. Beecher (quoted in Melzack 1973) concluded that:

> There is no simple direct relationship between the wound per se and the pain experienced. The pain is in very large part determined by other factors, and of great importance here is the significance of the wound .... In the wounded soldier (the response to the injury) was relief, thankfulness at his escape alive from the battlefield, even euphoria; to the civilian, his major surgery was a depressing, calamitous event. (p. 30)

A further example of the psychological component of pain can be seen in the report by Kosambi (1967) of the hook-hanging ritual in India. In this ceremony steel hooks, attached to strong ropes, are forced under the skin and muscles on both sides of the back and during the ceremony the chosen man swings free, hanging only from these hooks.

As a result of these and other reports showing the complexity of pain sensation, interest and research in pain has greatly increased. New theories on the physiology of pain have been advanced, for example Melzack's Gate-Control Theory of Pain (Melzack, 1973). Many experiments have also been carried out on the psychological component of pain, for example cultural differences in pain perception

(Lambert, Libman, and Poser, 1960; Tursky and Sternbach, 1967; Zborowski, 1952), sex and age differences in pain perception (Notermans and Tophoff, 1967; Schluderman and Zubek, 1962; Woodrow, Friedman, and Siegelaub, 1972), the effects of various experimental manipulations aimed at altering the subject's pain perception (Barber and Hahn, 1962; Gardner, Licklider, and Weisz, 1960; Kanfer and Goldfoot, 1966), and more recently the varying effects of different pain stimuli (Brown, Fader, and Barber, 1973; Davidson and McDougall, 1969).

The literature on pain and its various aspects is now large. In this thesis the emphasis will be placed upon studies directed towards the cognitive control of pain and some indication of the methodological difficulties in the area will also be given.

Spanos, Barber, and Lang (1974) have noted four major ways in which previous studies have examined the cognitive control of pain and in this review of the literature the studies will be organised according to Spanos et al's outline.

1. Leading the subject to believe the autonomic responses produced by the pain stimulus are due to something else.
2. Leading the subject to believe that he or she can control the intensity of the pain stimulus.
3. Instructing the subject to think of the

stimulated body part in a manner that is inconsistent with the perception of pain.

4. Instructing the subject to attend to events other than the pain producing stimuli.

1. Bandler, Madaras, and Bem (1968) and Nisbett and Schacter (1966) have shown that the subject's perception of pain can be manipulated by altering how the subject perceived his or her autonomic responses to the pain stimulus. Both studies used electric shock as the pain stimulus, however both studies used a slightly different method of manipulating the subject's pérception of pain.

In Nisbett and Schacter's 1966 study it was hypothesised that as long as the stimulus intensity is neither too low nor too high, the subject could be made to re-interpret the arousal caused by a stimulus as being due to some other stimulus. In the experiment subjects were divided into two groups, high and low fear groups. These subjects were then instructed on the side effects to be expected from the 'drug' given to them. One group was instructed that the side effects of the 'drug' would be some tremors, palpitations, an increase in breathing, and a sensation of butterflies in the stomach. These side effects were similar to those reported by previous subjects as experienced before and during the administration of electric shock. The other group was merely told to expect a number of side effects such as a numbness in their feet, a slight headache, and an itching sensation (all of which are unrelated to the side effects of electric shock).

As hypothesised by the experimenters, those subjects in the low fear condition who believed themselves to be in an artificial state of arousal due to the 'drug' they had been given did not attribute the shock-created arousal to the shock, but to the 'drug'. They found the shock less painful and were willing to tolerate more stimulation than subjects in the high fear condition.

Bandler, Madaras, and Bem's 1968 study put forward the hypothesis that a subject's response to a stimulus can be partly determined by the subject's observation of his or her own response to that stimulus. Thus, if a subject observed him or herself escaping from a series of painful stimuli he or she would rate these stimuli as more painful than in the case where subjects observed themselves enduring a series of painful stimuli. Subjective reports completed after the experiment supported this hypothesis; the subjects rated the discomfort of painful shocks they escaped from as being greater than the discomfort of the painful shocks they endured, even though all the shocks were of the same physical intensity.

2. Cognitive control of pain can be exerted by leading the subject to believe that he or she can control the intensity of the pain stimulus. Examples are provided in the research of Bowers (1968), Champion(1950), Corah and

Boffa (1970), Davison and Valins (1969), Glass, Singer, and Friedman (1969), Lepanto, Moroney, and Zenhausern (1965), and Zimbardo, Cohen, Weisenberg, Dworkin, and Firestone (1966).

Champion's 1950 study, similar in design to that of Bandler, Madaras, and Bem's (1968), appeared at first sight to have results contrary to those of Bandler et al. In his study Champion instructed one group of subjects that if they clenched their hand when the shock occurred this would terminate the shock. This was referred to as the movement (AM) condition. Another group of subjects was instructed not to move (the no movement or NM condition) and the last group was told to make a hand clenching movement of one second duration, which would not be related to the shock (the non-adaptive or N condition).

Using galvanic skin response (GSR) recovery measures Champion found that subjects in the AM (escape) condition showed a greater shift toward the pre-stimulus resistence level than in either the NM or N (no escape) conditions, although only the difference between the NM and AM conditions was significant. Corah and Boffa (1970) have hypothesised that the important difference between the two studies is in the method, as Bandler et al's study has the additional element of choice. Subjects could choose to escape or not escape whereas in Champion's study subjects had no choice. Corah and Boffa designed a study to replicate parts of both of these studies in order to show that the experimental results were not in fact contradictory in the way that they first appeared to be.

In Corah and Boffa's study there were four conditions; two choice (the subjects would choose to escape in either the escape or no escape conditions), and two no choice groups (the subjects could escape in the escape condition, but not in the no escape condition). Corah and Boffa found that the results of the two no choice groups were consistent with Champion's data, in which the stimulus escaped was rated as less painful, perhaps because of the subject's sense of control over the stimulus, which can be terminated at any time by the subject. The results of the two choice groups closely replicated the results of Bandler et al, in which the stimulus escaped was rated as more painful. From these results Corah and Boffa concluded that "the choice variable operates to reduce the aversive quality of the stimulus and the resultant physiological arousal" (p. 4).

Two other studies, one by Davison and Valins (1969) and the other by Glass, Singer, and Friedman (1969) have examined the variable of self control. Davison and Valins proposed that changes which an individual believes are brought about by him or herself will be maintained to a greater degree than changes perceived to be the result of external agents. To test this hypothesis, subjects were first given an electric shock to establish pain threshold and tolerance level; they were then given a drug (a placebo) which, they were told, would change their perception of pain. The drug did appear to alter pain perception, but only because the shock intensities in the next test were, unknown to the subjects, actually lower. The subjects were then divided into two groups, one of which was informed that the drug had been a placebo and the second of which was given no further instructions. Subjects were again tested and in this test the results indicated that those subjects who attributed the previous change in pain threshold to themselves, as they now knew that they had received a placebo, perceived the shocks as less painful and tolerated shocks of a significantly higher intensity than those subjects who continued to attribute the previous change in their behaviour to the drug.

Glass, Singer, and Friedman (1969), in a similar study, used unpredictable blasts of white noise as the aversive stimulus. One-half of the subjects were given button which they could use to terminate the noise, if they wished, but they were also encouraged to use the button only if they felt it was necessary. The other group of subjects was given no choice, but had to endure the blasts of noise contiguously with the assigned cognitive task. The results showed that those subjects given control over the stimulus showed greater tolerance for the noise, in terms of task persistence, than did the subjects who had no control over the stimulus.

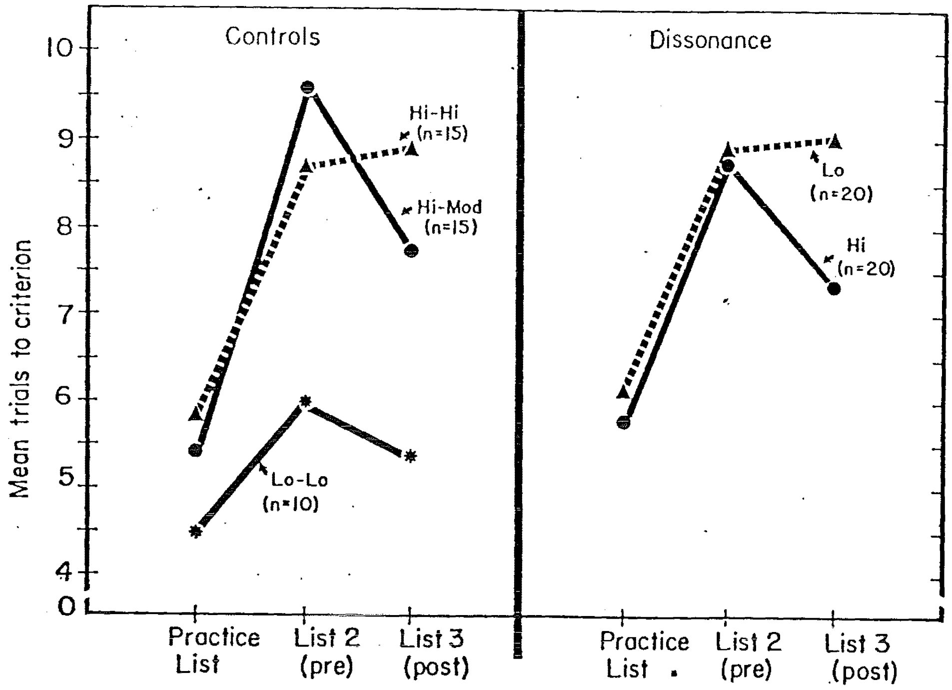
Bowers (1968) suggested that it is not the variable of control alone that affects the subject's perception of pain, but anxiety as an underlying factor of the control - no control variable. Subjects with no control over the administration of the painful stimulus experienced increased anxiety and rated the shocks as more painful than subjects who had some control over the administration of the stimulus. The results of Lepanto, Móroney, and Zenhausern (1965) also lend support to this view.

A study by Zimbardo, Cohen, Weisenberg, Dworkin, and Firestone (1966) examined a slightly different aspect of self control. Working from cognitive dissonance theory Zimbardo et al devised an experiment to test the application of this theory in the area of pain perception.

Cognitive dissonance theory states that if a person had knowledge of the unpleasantness of a situation (in this study the administration of a series of electric shocks during a learning task) and of his or her freedom to choose to avoid it, his or her agreeing to endure more of the situation is dissonant. The subjects in the study were divided into two groups after the first part of the experiment to establish threshold and tolerance base levels. The first group were given no choice and were told to continue; however the amount of shock administered during the learning task either remained high or was lowered to a moderate or low level. The other group of subjects were given a choice of continuing or not continuing the experiment (there was not a differential attrition rate between the choice and no choice groups). One-half of the subjects given a choice in continuing the experiment were given justifications for their continued participation (low dissonance group), and the other half were given no justification for continuing (high dissonance group).

It was hypothesised that to reduce the cognitive dissonance associated with continuing to endure an unpleasant situation, subjects in the high dissonance group would alter their perception of pain, and this did happen. The high dissonance group behaved very similarly to the high-moderate shock control group as measured by learning task performance and GSR measurements. The low dissonance group behaved very similarly to the high-high shock control group in threshold, tolerance, and learning task behaviour.

Figure 1. Mean number of trials to reach criterion in a serial-anticipation learning task (the greater the number, the poorer the learning). Zimbardo et al (1966) p. 218.




3. Cognitive control can apparently reduce pain if the subject is instructed to think of the stimulated body part in a manner that is inconsistent with the perception of pain, for example as numb and insensitive. Studies in this area have been done by Barber and Calverley (1969), Barber and Hahn (1962), Blitz and Dinnerstein (1971), Chaves and Barber (1974), Evans and Paul (1970), Johnson (1974), Scott and Barber (1977), and Spanos, Barber, and Lang (1974).

Most of these studies have concentrated on exploring the effect of suggested analgesia or anaesthesia by itself, or in conjunction with pleasant imagery, and most results have shown that these methods can reduce subjective reports of pain.

Barber and Calverley (cited in Chaves and Barber, 1974) found that pain produced by applying a heavy weight to a finger was attenuated when the subjects imagined that the finger was numb and insensitive. Similar results had been obtained by Barber and Hahn (1962) who, with ice water as the stimulus, examined the effects of hypnotically suggested and waking-imagined analgesia. They found these two methods to be equally effective in reducing pain experience as revealed by subjective reports, and reduction in respiratory irregularities and forehead muscle tension. However two other autonomic responses (cardiac acceleration and reduction inskin resistance), which are normally elicited by painful stimulation, were not affected by either measure.

Blitz and Dinnerstein (1971) also used ice water as the pain stimulus, but they instructed their subjects to dissociate the cold and pain components of the ice water by focusing on the cold, and focusing away from (or ignoring) the discomfort and pain. The second group of subjects were told to imagine it was a very hot day and the cold was pleasant. The subjects were further instruc that the experiment was to test their powers of concentra

For both groups the results showed a significant elevation in pain threshold, but not in the quit point, with males showing a greater increase in threshold than females in response to the experimental instructions. However as Blitz and Dinnerstein point out, there was a large degree of individual variation in response to the experimental instructions.

Chaves and Barber (1974) examined the effect of imagining pleasant events, and imagining one's finger to be insensitive, on the attenuation of pain when the pain stimulus is a heavy weight applied to the finger for two minutes. Their study had two additional elements: some subjects were led to expect a reduction in pain, but were not provided with any cognitive strategies, and for some subjects, the experimenter modelled, or acted out, the use of the cognitive strategies while he underwent painful stimulation. Chaves and Barber found that both imagining a pleasant event, and imagining the finger was insensitive, were effective in reducing pain. Subjects led to expect a reduction in pain, but not provided with any cognitive strategy, also experienced a reduction in pain, perhaps because they used cognitve strategies of their own. But the reduction was less than that shown by those subjects using the cognitive strategies the experimenter provided. The experimenter modelling was effective in reducing the verbal reports of pain only for subjects with high pretest levels who were asked to imagine pleasant events.

Evans and Paul (1970), using ice water as the stimulus, studied the effects of suggested analgesia, hypnotic induction and waking self relaxation, singly and in combination, on pain perception as measured by self report, heart-rate, and pulse volume. They found that suggestion produced reductions in self reports of distress, but neither suggestion nor hypnotic induction procedures reduced the physiological stress response.

Johnson (1974) compared the effects on pain perception (as measured by blood pulse volume, pulse rate, skin temperature, and subjective report), of suggestions for relaxation, for relaxation and imagined warmth, and for relaxation and imagined numbness. These suggestions did not affect the physiological measures, but the relaxation suggestions given alone or in conjunction with the suggestion to imagine the hand as numb, were effective in reducing subjective pain.

Scott and Barber (1977) in a very short report, using ice water and pressure pain (a Forgione-Barber stimulator), gave instructions to the subjects on how to interpret the pain sensation as non painful and on how to imagine pleasant events during stimulation. The dependent variables used were subjective rating of pain severity and tolerance measures. Scott and Barber, unlike the previous authors, reported that their experimental manipulations had no significant effect on pain perception. They also pointed out a number of problems with experiments in this area, including the fact that subjects use their own strategies during the control conditions thus enabling them to exhibit a very high tolerance of pain, most subjects reaching the three minute maximum.

Spanos, Barber, and Lang (1974) compared the effect of anaesthesia instructions on pain in hypnotic and non-hypnotic subjects, and in subjects who had either been, or not been exposed to demands for honesty in their reports of pain. The anaesthesia instructions were found to be effective in reducing pain ratings while the hypnotic induction process had a non significant effect. Spanos et al reported that there seemed to be a trend for subjects to report more pain when they were exposed to demands for honesty, but there were no significant differences between subjects.

4. Finally, Spanos, Barber, and Lang (1974) pointed out that cognitive control can be exerted by instructing the subject to attend to events other than pain producing stimuli, for example imagining a pleasant scene. Barber, and Cooper (1972), Hall and Stride (1954), Kanfer and Goldfoot (1966), and Spanos, Horton, and Chaves (1975) provide examples of this approach.

Spanos, Horton, and Chaves (1975), using ice water, compared the effects of a relevant pain strategy (imagining a situation that, if real, would be inconsistent with pain) and an irrelevant strategy (imagining a situation that is unrelated to the pain). The results showed that the strategies did not alter the pain thresholds of subjects with low pretest thresholds, perhaps because the time between the onset of stimulation and pain threshold was so brief that there was not enough time for the subject to become involved in the suggested strategy and so re-interpret their sensory experience. This was supported by the finding that subjects who were highly involved in their imaginings showed greater increases in pain threshold than those subjects who were not so highly involved in their imaginings.

For those subjects with high pretest thresholds the use of the relevant strategy produced a greater increase in threshold than did the irrelevant strategy, which, in turn, produced a greater increase than in the control condition, but it was unclear exactly why. As Spanos et al point out it is largely unclear as to why the use of cognitive strategies does lead to reductions in reported pain. They suggest that the pattern of imaginings that absorbs the attention will elevate pain threshold and reduce reported pain. From this it could be hypothesised that the more a strategy absorbs the attention the more it will elevate pain threshold. So other strategies, such as cognitive tasks like adding aloud, reading, watching, or listening to a story may prove even more effective in reducing reported pain.

Barber and Cooper (1972) studied the relative effectiveness of three distractors in reducing the pain subjects experienced. The distractors used in the study were listening to a tape recording of a story, adding aloud (in multiples of seven), and counting aloud (repeating the numbers 1,2,3,4). These distractors had not previously been tested for their effectiveness in reducing pain and, as the experimenters point out, more study is needed to discover other effective distractors, especially those which do not require special equipment and can be used by individuals in natural settings. Such distractors also need to be examined using different pain producing stimuli (Barber and Cooper used the Forgione-Barber stimulator, whereas this experiment studied the effect of distractors on pain induced by the cold-pressor test).

Barber and Cooper's results showed that listening to a tape and adding aloud significantly reduced the pain ratings below those of the control group. Furthermore, while these distractors tended to reduce the pain ratings below those of the third experimental group (counting aloud) this effect was non significant. It was thought by the present author that listening to a tape and adding aloud may have been more effective distractors as they require more concentration on the part of the subject than repeating the numbers 1,2,3,4 aloud. So in the experiment to be described in the next chapter, the stimuli used as distractors were the watching of a video-tape of several cartoons and the task of counting backwards, in threes, aloud.

The experiment by Barber and Cooper also revealed that subjects tend to have their own methods of distracting themselves from the pain when this factor is left uncontrolled. Methods used by subjects included self-timing, looking out of a window, concentrating on a specific feature of equipment in the room, staring at a picture of a flower on the wall, and thinking pleasant thoughts. In the present study an attempt was made to control some of these methods of distraction by making the experimental room as featureless as possible.

An earlier experiment by Kanfer and Goldfoot (1966) used verbalizing aloud as one of the distractors, the others being self-pacing with a clock and the presentation of slides. They found that verbalizing aloud was the least effective of the three distractors. Perhaps because it drew attention to the aversive effects of the pain stimulus, this 'distractor' in fact enhanced the subject's tendency to withdraw from the pain stimulus. The results also showed that subjects kept their hand in ice water significantly longer in the verbalizing condition than in the control condition.

Kanfer and Goldfoot point out that the subjects' use of their own distractors during the control conditions makes the experiment, in effect, a comparison between the effectiveness of the distractors provided by the experimenter and those usually employed by the subjects. Kanfer and Goldfoot, on questioning their subjects, found that in the condition where slides were used as the distractor, very few subjects reported the use of any other distractor, and so Kanfer and Goldfoot tentatively conclude that if the experimenter-supplied distractor is effective, as the slides for example were, then subjects will not utilize additional distractors of their own.

Kanfer and Goldfoot, in their control condition, also attempted to disguise, to some extent, the aim of the experiment. The instructions they gave to subjects stated that:

> We are interested in measuring some physiological changes that occur in people under various circumstances. For the first part of this experiment I would like you to wear these electrodes around your arm. They will measure the electrical activity in your skin. Now when I tell you to, please place your hand in this cold water, and keep it there as long as you can. (p. 31)

The experimenter then left the room to take some readings.

A much earlier experiment by Hall and Stride (1954), while examining pain tolerance in psychiatric patients, also varied the experimental instructions. The results showed that:

> By varying the form of instruction given prior

> to the experiment, it was possible to raise the response to pain considerably higher than the general average for the original condition indicating that low tolerance of pain is often, in these patients, due to anticipation of pain rather than actual experience of it. (p. 59)

To examine this question further, the subjects' knowledge of the aim of the experiment was manipulated in the present experiment as outlined in Chapter III.

Most studies using cognitive strategies to manipulate pain perception have found that such manipulation can reduce the subjects' reported experience of pain. The major problem with these findings is whether these reported changes in pain perception actually represent a change in pain perception or merely a change in the subjects' response bias. As Spanos, Barber, and Lang (1974) point out, many subjects were aware that they were participating in experiments in which methods of reducing pain were being tested. The subjects may have reported a greater degree of pain reduction than they actually experienced in order to comply with the demands of the experimental situation.

However Spanos et al (1974) found that a strong demand for honest reports had no effect on the magnitude of the reported pain reductions and they concluded that subjects using cognitive strategies may actually feel less pain; they are not simply reporting less pain.

Johnson (1974) also supports this view stating that those subjects instructed to imagine their hand was warm while immersed in ice water were led, as were the other experimental groups, to expect reductions in pain, and yet unlike the other experimental groups these subjects showed no attenuation in pain when compared with the uninstructed controls. Research by Zimbardo, Cohen, Weisenberg, Dworkin, and Firestone (1966) further supports this view. In their experiment subjects in the high dissonance condition who endured a continuously high level of shock exhibited decreases in their GSR similar to those subjects in a group which had a high level of shock that was subsequently reduced to a moderate level of shock. This high level shock group also improved their performance on a learning task as much as the high-moderate shock group. As the number of trials required to reach criterion is a function of the level of shock intensity Zimbardo et al concluded that this was evidence that there had been a change in the actual physiological perception of pain and not just in the subjects' response criterion.

The studies briefly reviewed above reveal a number of problems. In the voluminous literature on pain perception there is little or no agreement on the definitions of pain, pain threshold, or tolerance; the instructions given to the subjects prior to participation in the experiment vary widely, as do the dependent variables used in the experiment, and the methods used to measure the subjects' pain perception.

Two definitions of pain, one by Liebeskind (1977) and one by Melzack (1973), illustrate the problems facing anyone trying to define pain. Liebeskind states that:

> Pain means many different things and the variables which correlate with, inhibit or enhance one kind of pain, and the neural mechanisms which underlie it, may not be associated with, or influence other kinds. (p. 41)

Melzack also gives an indication of the problems of pain measurement:

> The word 'pain' represents a category of experiences, signifying a multitude of different causes, and characterized by different qualities varying along a number of sensory and affective dimensions. (p. 46)

Much of the early research and even much current research is hampered by differing definitions of pain threshold and tolerance. Some experimenters use completely unique terminology as well as unstandardized methods of measuring pain, as Wolff (1964) points out. For example, Brown, Fader, and Barber (1973) defined pain threshold as the total time elapsing between the beginning of stimulation and the first report that 'it hurt'. Similarly pain tolerance was defined as "the total time elapsing from the beginning of stimulation till the subject removed his or her hand".

Wolff also used this criterion for pain tolerance, further defining it as "the upper limit of pain an individual is willing to accept under given experimental conditions", but defined pain threshold as "that stimulus value which gives rise to just noticeable pain". Wolff felt that such differing criteria could account for varying experimental results in studies of the relationship between pain threshold and tolerance and studies of the effect of experimental instructions of threshold and tolerance levels.

In contrast to the above criteria for pain tolerance, Gelfand (1964) defined pain tolerance as the time from pain threshold to withdrawal from the stimulus. In this present experiment Wolff and Brown et al's approach has been followed. An outline of the reasons their approach was used is given in Chapter III.

Another factor often ignored in experiments of pain perception is that of the experimental instructions for the control condition and subjects. These instructions are not thought to have any effect on pain perception. However they may be of considerable importance, as has been shown by Blitz and Dinnerstein (1968), Gelfand (1964), Poser (cited in Wolff, 1964), Wolff (1964), Wolff and Horland (1967), and Wolff, Krasnegor, and Farr (1965).

The first studies carried out on the effect of instructions on pain perception showed that the manipulation of instructions affected the pain tolerance level. Wolff (1964) then tentatively concluded that tolerance is primarily determined by psychological variables and threshold by physiological variables, but as Blitz and Dinnerstein (1968) pointed out the instructions used in Wolff's various experiments were such that they would, a priori, be more likely to influence pain tolerance than pain threshold. For example, Wolff and Horland's instructions:

> As the current (electric shock) continues to increase I want you to say 'PAIN' as soon as the first sensation changes to pain. I repeat, whenever the sensation changes into any kind of pain, ache or hurting sensation I want you to say 'PAIN' straight away .... As the current continues I want you to shout 'STOP' when you do not want to take any more of this painful sensation. (Wolff and Horland, 1967, p. 403)

Then in the permissive instruction condition the following additional instructions were given:

> But this time I really want to test how tough you are because I want you to imagine that I am going to give you a hundred dollars for every second you can wait before shouting 'STOP' after you begin to feel pain ... but to wait as long as you can until you really cannot stand the pain anymore .... This kind of pretense usually helps people in taking more pain than before. (p. 404)

Blitz and Dinnerstein stated that even at low and moderate levels of aversive stimulation, psychological processes, such as interpretation, judgement, and timing will influence the perception of pain and so determine the threshold level. These processes can be affected by instructional variables and Blitz and Dinnerstein's instructions were aimed at altering the threshold levels:

> I shall continue to increase the current and when the sensation begins to give you the

> slightest amount of pain, ache, or starts to hurt, I want you to say 'pain' .... I want you to be certain that when you say 'pain', the 'current experience' is actually pain. Many people confuse a feeling of strong discomfort with pain. I want you to report 'pain' only when the experience begins to be clearly painful and not just strong discomfort. (p. 277)

Blitz and Dinnerstein observed an increase in pain threshold as a result of these instructions, although this could have been due to a shift in the subjects' criteria for pain.

Problems also arise from the different measures used, not only in the various ways of timing the threshold or tolerance variations, but also in whether subjective reports of pain, with or without demands for honesty, are used. Some studies make use of physiological measures, but even these range from heart rate, forehead tension, pulse volume, to skin temperature.

Wolff (1978) has found some problems with such physiological measures. Any physiological responses to pain tend to have a slight latency in response to stimuli; the autonomic nervous system (ANS) reactivity fades with repeated presentation of the noxious stimulus, and if there are any extraneous stimuli these will produce an ANS response independently of the experimental stimulation. Wolff concludes that these evoked ANS responses are non-specific and indicative of arousal rather than pain.

Hilgard (1969) in support of this view has pointed out that:

> A satisfactory physiological indicator of pain is one which is present (or increased) when pain is felt, and absent (or reduced) when pain is not felt .... there is at present no single accepted indicator of pain that can be counted to vary in an orderly way with degrees and absence of pain. (p. 103-104)

In some ways the subjective response would seem to be the best indicator, as the individual knows best what he or she feels, but even so there are problems with individual differences in pain perception, and with previous experience and use of pain terminology (about which there is very little agreement). No one method of measurement is fully satisfactory, largely because any such method must be at least partly inferential due to the subjective nature of pain (Mersky, 1973).

There are also problems in the methods employed to measure the various pain stimuli used - electric shock, radiant heat, ice water, mechanical pressure - and how to equate these various stimuli, for the type of pain they produce is different in length of time of stimulation, short and sharp or long, dull, and aching. These sources of pain also differ in familiarity. Ice water, radiant heat, and mechanical pressure are all reasonably familar, but electric shock is not, and is often anxiety arousing as Haslam (1966) showed. Experiments use different stimuli and at times very little mention is made of whether the effects observed with one stimulus will generalize to other stimuli. Very few experiments have examined more than one pain stimulus.

Some of the studies to do this are Brown, Fader, and Barber (1973), Clark and Bindra (1956), Davidson and McDougall (1969), Scott and Barber (1977), and Wolff and Jarvik (1963 and 1964). Such studies have typically correlated the pain thresholds and tolerances for various pain stimuli.

Clark and Bindra, in their 1956 study, compared the threshold levels of pain induced by pressure (using a clinical sphygmomanometer), radiant heat, and electric current. Their results showed that there were considerable individual differences in threshold in all three methods. Thermal pain threshold was less variable than either the pressure, or mechanical pain threshold with the electric pain threshold the most variable. The results also showed that the pain thresholds were significantly intercorrelated, as measured by rank order correlations.

Wolff and Jarvik (1963), in a study later replicated and extended in 1964, compared methods of producing deep somatic and superficial pain. They were unable to find a relationship between the pain threshold of a stimulus producing deep somatic pain (a dull, aching pain; poorly localized, of long latency and duration) and superficial pain (a sharp, well defined pain of short latency and duration).

In their 1964 study Wolff and Jarvik compared the threshold and tolerance levels between radiant heat and cold-pressor (producing superficial pain) and hypertonic and hypotonic saline, in which the saline is injected in to the gluteus medius muscle (producing deep somatic pain). The only significant correlations observed were those between the two methods of inducing superficial pain and the two methods of inducing deep somatic pain.

Wolff and Jarvik were concerned that experimental laboratory studies were studies of manipulated pain, which is not identical to pain observed clinically. Experimental pain is generally endured for only a relatively short time in an acute form whereas most clinical pain is chronic, dull, and aching. They are concerned to devise a form of experimental pain which is more closely similar to that of clinical pain so that experimental results may be generalized to the clinical setting. More studies are needed to establish the relationship between experimental and clinical pain, but before this can be done there needs to be some agreement on the definitions and measures to be used.

Davidson and McDougall (1969) compared threshold and tolerance levels for cold-pressor, pressure algometer, shock, and radiant heat. Each stimulus was measured differently, in order, from threshold to withdrawal, pressure at stop, highest shock intensity, and time from onset to the end of stimulation. Significant correlations were found between pressure and cold tolerance, and between pressure and shock tolerance, but this pattern did not hold consistently with threshold levels nor with correlations between threshold and tolerance levels. The only consistent relationship was that between cold and pressure, which was significant for both threshold and tolerance.

Brown, Fader, and Barber (1973) used three measures of pain responsivity; threshold, tolerance, and ratings of intensity, to measure the relationship between two pain sources - ice water and the Forgione-Barber pain stimulator. Their results corroborate those of Davidson and McDougall, which showed that both cold threshold and tolerance levels are significantly intercorrelated with pressure threshold and tolerance levels. The results also indicate that individuals who more quickly report pain when stimulated by extreme cold also rate pressure pain as more intense. Scott and Barber's 1977 report also supports Brown et al and Davidson and McDougall's findings.

In their studies the above experimenters have pointed out various difficulties in research comparing a number of pain stimuli. There is a need to clarify the relative importance of the intensity of pain as opposed to the duration of stimulation - an effect that can be partly seen in Wolff and Jarvik's work comparing pain of long and short duration. There is also a need for a general definition of pain, though this is a difficult task.

The area of pain measurement also presents difficulties to any experimenter attempting to compare the effects of a number of different pain producing stimuli, and until these problems are solved it will be difficult to ascertain the generality of experimental results and the relationship between the various types of pain stimuli used in research.

In this review of the literature a number of areas have been noted in which further investigation of the experience of pain is called for. In particular the effect of knowledge of the aim of the experiment on pain experience (Hall and Stride, 1954; and Kanfer and Goldfoot, 1966), the effect of differing cognitive strategies and the need for effective distractors that can be used by individuals in natural settings (Barber and Cooper, 1972) are in need of further clarification.

# CHAPTER II

## RESEARCH HYPOTHESES AND RESEARCH DESIGN

### AIMS OF THIS STUDY

It was decided to conduct an experiment which examined two hypotheses, one relating to the knowledge of the aim of the experiment and the other relating to the effect of cognitive strategies on pain experience. The experimenter attempted to manipulate the subjects' knowledge of the aim of the experiment by varying the experimental instructions. (The instructions are given in detail in Chapter III.) Previous experiments have shown that both the experimental instructions and the subjects' knowledge that the experiment is to examine pain experience can alter the experimental results (for example, Blitz and Dinnerstein, 1968; and Hall and Stride, 1954).

To test the second hypothesis two distractors were used in this experiment. They consisted of counting aloud and watching a videotape, and will be described in detail in the following chapter. These distractors were chosen because they require concentration on the part of the subject and no special equipment, so it was reasoned that they might be more effective than some of the distractors used in past experiments on pain. An advantage of these distractors is that they require no special equipment and so they may be more easily used by individuals in their homes, for example.

RESEARCH HYPOTHESES

From the above considerations the following research hypotheses were formulated.

1. Knowledge of the aim of the experiment will increase tolerance level.

2. As the level of distraction increases tolerance level will also increase.

RESEARCH DESIGN

The research design used in this experiment was an incomplete three-way factorial design with repeated measures on factors B and C. The first factor, factor A, was knowledge of the aim of the experiment. Two levels of knowledge were used; $A_1$ - no knowledge of the aim of the experiment and $A_2$ - knowledge of the aim of the experiment. Factor B represented the level of distraction from the painful stimulus provided by the experimenter. Three levels of distraction were employed; $B_1$ - no distraction, $B_2$ - videotape alone, and $B_3$ - videotape and counting aloud. Factor C was the temperature of the water; $C_1$ - cold, and $C_2$ - warm. The warm water was used as a control to enable the experimenter to establish the base rate of response to the distractors provided. It also provided a means of returning the subject's hand to room temperature between successive levels of distraction.

In this design there were two empty cells $A_1(B_1C_2)$ and $A_2(B_1C_2)$. These two cells were a combination of the no distraction, warm water stimuli conditions for both the no knowledge and knowledge levels. These cells were left empty because they were not logically compatible with the instructions given to the subjects in the $A_2$ (no knowledge) condition, which stated that the experiment had been set up to examine information processes and not, as was actually the case, to examine pain perception. It was felt that to have the condition $A_1(B_1C_2)$ would alert subjects to the true aim of the experiment.

Figure 2. Diagram of the research design.

| | $B_1$ No Distractors | | $B_2$ One Distractor | | $B_3$ Two Distractors | |
|---|---|---|---|---|---|---|
| | $C_1$(cold) | $C_2$(warm) | $C_1$(cold) | $C_2$(warm) | $C_1$(cold) | $C_2$(warm) |
| $A_1$ No Knowledge | S 1 | Empty cell | S 1 | S 1 | S 1 | S 1 |
| | S 2 | | S 2 | S 2 | S 2 | S 2 |
| | S 3 | | S 3 | S 3 | S 3 | S 3 |
| | S 4 | | S 4 | S 4 | S 4 | S 4 |
| | S 5 | | S 5 | S 5 | S 5 | S 5 |
| | S 6 | | S 6 | S 6 | S 6 | S 6 |
| $A_2$ Knowledge | S 7 | Empty cell | S 7 | S 7 | S 7 | S 7 |
| | S 8 | | S 8 | S 8 | S 8 | S 8 |
| | S 9 | | S 9 | S 9 | S 9 | S 9 |
| | S 10 | | S 10 | S 10 | S 10 | S 10 |
| | S 11 | | S 11 | S 11 | S 11 | S 11 |
| | S 12 | | S 12 | S 12 | S 12 | S 12 |

# CHAPTER III

## METHOD

### SUBJECTS

The subjects in this experiment were all first year Psychology students from a laboratory class in which the experimenter participated in the teaching. Thus the subjects were all acquainted with the experimenter.

Twelve subjects were used in this experiment - six males and six females, all aged between 18 and 22 years. The subjects were first divided according to sex and then randomly assigned to one of two conditions - $A_1$ or $A_2$ (no knowledge and knowledge) - by tossing a coin.

### APPARATUS

The pain stimulus was obtained by filling a bucket with cold water and adding ice until the temperature of the water dropped to $0^{o}C$. The temperature of the water was thereafter monitored and kept between $0^{o}$ and $2^{o}C$ by the addition of fresh ice. The use of ice to cool the water may have led to a problem in that when there was a large amount of ice in the water it came in contact with the subject's hand and one or two subjects reported that their hand felt colder where the ice was touching it. The control stimulus consisted of cold tap water maintained at $18^{o}C$.

The videotapes shown to the subjects were off-air videotape recordings of several television cartoons. The cartoons shown were as follows:

1. The Flintstones (Hanna-Barbera) 23.50 minutes
2. The Flintstones (Hanna-Barbera) 23.50 minutes
3. The Flintstones (Hanna-Barbera) 22.00 minutes
4. Merry Melodies (Warner Brothers) consisting of three cartoons each approximately 5.50 minutes.

Unfortunately it was, at the time, impossible to obtain four Flintsones' cartoons. The introduction of this uncontrolled variable may have affected the results of this experiment. Subjects had to watch a number of short cartoons instead of only one cartoon. One subject mentioned that it was much harder to concentrate and remember a number of different short cartoons than to recall the details of a single Flintstones' cartoon.

The pairing of the videotapes with the various experimental conditions was varied so that no one cartoon was shown exclusively in any one condition. Further, to ensure that subjects concentrated on the videotapes, they were instructed that they would be tested on how much of the cartoon they remembered at the end of each session.

## PROCEDURE

There were two major conditions $A_1$ and $A_2$ (no knowledge and knowledge of the experimental aim), which were further divided into five sub-conditions, as shown in the diagram of the research design. Each subject started the experiment in an experimental ($C_1$) condition. Thereafter control ($C_2$) conditions and experimental conditions were alternated. Within these limits the order of presentation was decided randomly (by tossing a die) with no order of presentation being repeated for any two subjects.

The subject entered the experimental cubicle, which was small (1 m 1.56 cm by 1 m 4.73 cm), darkened, and as featureless as possible, apart from a chair placed in front of a bench, which had a small sink in it. This was done in order to, at least partially, combat the use of various features of the experimental room, such as looking out of a window and looking at various pieces of equipment, as uncontrolled distractors.

Each subject was interviewed after the experiment to discover if he or she had used any distractors, apart from those supplied by the experimenter. It was stressed to the subject that honesty in answering post-experimental questions was necessary. Subjects were asked what they thought of during the condition $B_1C_1$ (cold water, no distractor). This questioning was aimed at establishing whether or not they had tried to distract theyselves from the pain.

To the subject's right, beside the sink was placed a tape-recorder. This was used to make a complete record of all the subjects' verbalizations during the experiment. Placed beyond the sink, directly in front of the subject was a video monitor, which blocked the subjects' view of the adjoining room, from which the experimenter controlled the experiment.

Figure 3. The experimental room.

On entering the experimental room the subject was greeted by the experimenter, asked to sit at the bench, and then the appropriate instructions for the various experimental conditions were read aloud by the experimenter as follows. Firstly general instructions were read to the subject to establish the two conditions corresponding to the two levels of factor A (the knowledge factor).

These two major conditions were set up to examine questions raised by an earlier experiment by Hall and Stride (1954) which found that pain tolerance could be affected by the anticipation of pain.

<u>$A_1$ (No Knowledge)</u>

"This experiment has been set up to examine divided attention tasks. I want to determine the degree to which you can effectively and without loss of information process information from a number of different sources. To do this you will be required to monitor a varying number of different stimuli."

<u>$A_2$ (Knowledge)</u>

"This is an experiment to discover more about painful stimuli as this type of data may be useful in treating people who suffer from chronic pain. Previous experiments have shown that other stimuli, for example auditory or visual stimuli or cognitive tasks may affect a person's experience of pain, lowering the amount of pain felt. To examine this you will be required, while your non-preferred hand (that is the hand that you do not write with) is immersed in cold water, to monitor an audiovisual stimulus (a videotape) and perform a cognitive task (counting backwards in threes)."

These instructions were given after subjects were told that they could withdraw from the experiment at any time they wished. The instructions were designed to discover if knowledge that the experiment was to investigate pain perception would cause subjects to endure more pain in an effort to support the experimenter's first hypothesis. Orne (1962) and Rosenthal (1951) have both shown that subjects try to please the experimenter by giving the 'correct' responses in order to support experimenter's hypothesis, as they see it. Conditions $A_1$ and $A_2$ in the present experiment were an attempt to control for this effect by attempting to disguise the aim of the experiment. After the experiment the subjects were questioned as to what they thought the experiment was about, once the experimenter had explained that honest replies were most important. Those subjects who were in the $A_1$ condition were told the true aim of the experiment and the reasons for the particular instructions, which did not reveal the true aim of the experiment.

The first set of instructions was followed by more specific instructions for whichever combination of the levels, within the three factors, that the subject was first being tested under.

$\underline{A_1(B_1C_1)}$ <u>(No Knowledge, No Distractor, Cold Water)</u>

"In this session you will be required to monitor only one stimulus - cutaneous sensation, in this case cold water. You will immerse your non-preferred hand (that is the hand that you do not write with) up to the wrist in a basin of cold water. On immersing your hand I would like you to report any sensations you feel, for example if the sensation you feel is pleasant, cool, cold, uncomfortable, unpleasant, or painful. After this I would like you to report whenever the sensation you feel in your hand changes - from cool to cold, pleasant to unpleasant, or uncomfortable to painful. It is important that you should keep your hand in the water as long as you can so that I can compare the results of this session with the next one in which you will be monitoring a number of different stimuli."

$\underline{A_1(B_2C_2)}$ <u>(No Knowledge, One Distractor, Warm Water)</u>

"In this session you will be required to monitor three stimuli - visual, auditory, and cutaneous. You will immerse your non-preferred hand (that is the hand that you do not write with) up to the wrist in luke-warm water. On immersing your hand I would like you to report any sensations you feel, for example if the sensation you feel is pleasant, warm, hot, uncomfortable, unpleasant, or painful. After this I would like you to report whenever the sensation you feel in your hand changes, for example from hot to warm, pleasant to unpleasant, or uncomfortable to painful. It is important to keep your hand immersed until the videotape has finished so that you are monitoring all the stimuli throughout the session. At the end of the session you will have to report back on the videotape you saw, telling me as many details as you can about the characters and the story."

<u>$A_1(B_2C_1)$ (No Knowledge, One Distractor, Cold Water)</u>

"In this session you will be required to monitor three stimuli - visual, auditory, and cutaneous. You will immerse your non-preferred hand (that is the hand that you do not write with) up to the wrist in cold water. On immersing your hand I would like you to report any sensations you feel, for example if the sensation you feel is pleasant, cool, cold, uncomfortable, unpleasant, or painful. After this I would like you to report whenever the sensation you feel in your hand changes, for example from cool to cold, pleasant to unpleasant, or uncomfortable to painful. It is important to keep your hand immersed until the videotape has finished so that you are monitoring all the stimuli throughout the session. At the end of the session you will have to report back on the videotape you saw, telling me as many details as you can about the characters and the story."

$A_1(B_3C_2)$ (No Knowledge, Two Distractors, Warm Water)

"In this session you will be required to monitor three stimuli - visual, auditory, and cutaneous. In addition you will be given a mental arithmetic task consisting of counting backwards in threes. You will immerse your non-preferred hand (that is the hand that you do not write with) up to the wrist in luke-warm water. On immersing your hand I would like you to report any sensations you feel, for example if the sensation you feel is pleasant, warm, hot, uncomfortable, unpleasant, or painful. After this I would like you to report whenever the sensation you feel in your hand changes, for example from hot to warm, pleasant to unpleasant, or uncomfortable to painful. It is important to keep your hand immersed until the videotape had finished so that you are monitoring all the stimuli throughout the session. At the end of the session you will have to report back on the videotape you saw, telling me as many details as you can about the characters and the story."

$A_1(B_3C_1)$ (No Knowledge, Two Distractors, Cold Water)

"In this session you will be required to monitor three stimuli - visual, auditory, and cutaneous. In addition you will be given a mental arithmetic task consisting of counting backwards in threes. You will immerse your non-preferred hand (that is the hand that you do not write with) up to the wrist in cold water. On immersing your hand I would like you to report any sensations you feel, for example if the sensation you feel is pleasant, cool, cold, uncomfortable, unpleasant, or painful. After this I would like you to report whenever the sensation you feel in your hand changes, for example from cool to cold, pleasant to unpleasant, or uncomfortable to painful. It is important to keep your hand immersed until the videotape has finished so that you are monitoring all the stimuli throughout the session. At the end of the session you will have to report back on the videotape you saw, telling me as many details as you can about the characters and the story."

Instructions for the two levels of the knowledge factor (factor A) varied as little as possible in the various combinations of factors B and C outlined above.

After the instructions had been given the subject was permitted to ask any questions he or she may have wished, in order to clarify what he or she had to do during that particular condition. The bucket of cold water was then placed in position in the sink in front of the subject. Next the tape recorder and, if required, the videotape were switched on. The experimenter then left the experimental room, closed the adjoining door, started a stop clock, and instructed the subject to put his or her non-preferred hand in the water. If the subject was serving in condition $B_3$ (two distractors, the videotape and counting aloud) he or she was then instructed to count backwards, in threes, starting from a three figure number chosen at random by the experimenter. It was felt that this stimulus would be more effective than the stimulus of counting aloud (repeating the numbers 1,2,3,4) used in Barber and Cooper's 1972 study, because it requires more concentration on the part of the subject.

From her position in the experimental room the experimenter could see the subject's hand in the bucket of water. This ensured that the subject immersed his or her hand fully into the water, consequently the experimenter was able to note at what stage the subject withdrew his or her hand from the ice water.

Most subjects were aware of the fact that the experimenter could hear them (they knew that they were being taped) and one subject noticed that he was being watched; other subjects did not mention noticing this so it is uncertain if the remaining subjects knew that they were being observed.

If the subject 'requested out', that is requested to be allowed to withdraw his or her hand from the water a standard reply was given:

> "It is important that you keep your hand immersed as long as possible, however if you feel that you cannot keep your hand in any longer you can take it out."

In wording this reply the experimenter attempted to phrase it so that the subjects did not feel compelled to keep their hands in the water. Though this may, in fact, have been the case as one subject 'requested out' in condition $B_1C_1$ (no distractors, cold water) after 115 seconds, but thereafter kept his hand immersed for the full ten minutes (the maximum stimulus exposure the experimenter allowed).

The major measure used in this experiment was tolerance level as defined by Wolff (1964) and Brown, Fader, and Barber (1973), namely, the total time elapsing from the beginning of stimulation until the subject withdraws from the stimulation. This criterion was chosen because in this experiment the experimenter did not specifically ask the subjects to report 'when it first hurt' as subjects in one condition, $A_1$ (no knowledge), were not told the real purpose of the experiment and so were asked only to report when the sensation they felt altered, for example 'from warm to cold, pleasant to unpleasant, or from uncomfortable to painful'. These instructions were also given to subjects who had knowledge of the exact purpose of the experiment. As a result of these instructions, threshold measurements were not always obtained from subjects and so tolerance had to be defined as the total time of stimulation the subject endured.

In addition the number of errors in counting backwards, the number of points remembered from the videotapes, and the timing and number of comments made by the subjects on the sensations they experienced in their hands were recorded. Unfortunately it was not possible for physiological measures to be taken.

# CHAPTER IV

## RESULTS

### INTRODUCTION AND DEPENDENT VARIABLES

To evaluate the results of this study seven different dependent variables were examined. These dependent variables were obtained from the recordings made during each session. The variables were transcribed by classifying the subjects' responses into seven different categories and coding them onto data cards.

Each dependent variable was the subject of separate analysis of variance. Because of the two empty cells discussed previously, a separate two-way analysis of variance was carried out on each dependent variable. The repeated measures design was achieved by nesting the subjects within factor A (knowledge) which is expressed in the analysis of variance summary tables as S(A). These analyses of variance were computed using the Biomedical Statistical Package, BMD 08V programme which was set up as outlined in Afifi and Azen (1972).

The seven dependent variables recorded and analysed were as follows:

1. Number of withdrawals.

This is a measure of whether or not the subject withdrew from the painful stimulus. The number of withdrawals made during each condition was noted but as the number of subjects who withdrew in any one condition was never more than four, no statistical analysis was made of these data. Graphs of the data are provided to illustrate any trends present (see Figures 4 and 5).

2. <u>Time of withdrawal</u>.

This is a measure of the time, in seconds, at which the subject withdrew from the stimulus in each condition. This variable was treated as equivalent to a tolerance variable, however a similar problem to that encountered with the first dependent variable (a high proportion of subjects enduring stimulation for the maximum time) makes any conclusions drawn from these data tentative.

3. <u>The number of 'requests out'</u>.

This was defined as the first request by the subject to withdraw from the stimulus, whether or not the subject then withdrew from the stimulus at this point in the experiment. In all but two cases the subject actually withdrew from the stimulus after 'requesting out'. Only the first 'request out' was recorded as one subject, in the $A_1(B_1C_1)$ condition (no knowledge, no distractor, cold water) 'requested out' twice. As outlined in the descriptions of the first two dependent variables there were a number of cells in which only one subject 'requested out'. The data was badly skewed so again an analysis of variance was inappropriate. Two graphs are presented to demonstrate the trends present in the data (see Figures 7 and 8).

4. The total number of comments.

This was used to measure the effect of knowledge of the aim of the experiment and the effect of the distractors on pain tolerance. Only comments relating to the sensation the subject felt in his or her hand were used in the data analysis. So comments such as 'Oh no', 'Let's see', 'Sorry', 'Curses', 'Oh, I'll say', or 'No' were not included in the data analysis.

5. The time of first comment.

This was a measure of the time of the first complaint made by the subject about pain, discomfort, unpleasantness, or soreness in his or her hand. The subjects were not asked to report when they first felt a sensation of pain in their hands as it was reasoned that this would alert subjects in the $A_1$ (no knowledge) condition to the true aim of the experiment. Subjects were only asked to comment on any change of sensation in their hands. The experimenter supplied some terms the subjects could use - 'cool to cold; pleasant to unpleasant; or uncomfortable to painful'. The subjects did tend to use these terms but they also used their own terms and it became obvious that each subject interpreted the terms differently. Certain subjects never used the word painful during the trials with the ice water and at times the terms unpleasant and uncomfortable were used either before or after the subject reported his or her hand was painful or sore.

6. The number of points remembered.

This was calculated by counting every point the subject remembered about the videotape, not including points remembered incorrectly or points that the subject repeated more than once. Subjects were told at the beginning of the experiment that they would be questioned at the end of each videotape to discover how many points they could remember. Subjects were asked by the experimenter 'What can you tell me about the story you just saw?' There was considerable variability between subjects on the number of points they remembered from the story, as shown in figures 11 and 12.

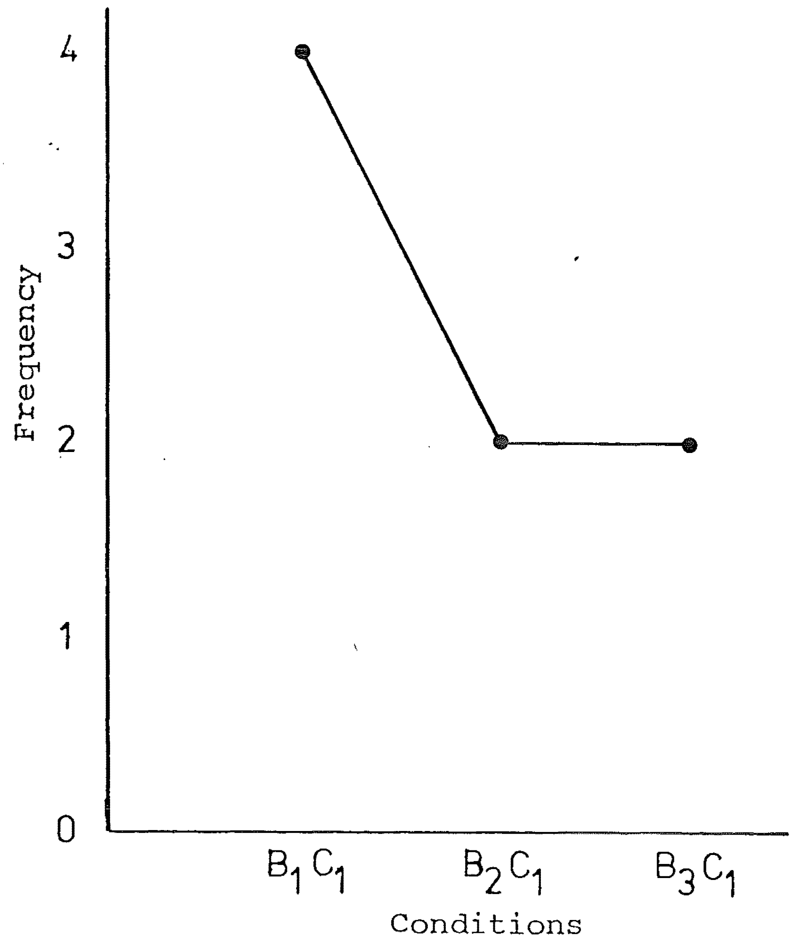
7. The number of errors in backwards counting.

A complete record of the subjects' backwards counting was made. This was later transcribed and the number of errors in the backwards counting were tallied. An error was defined as incorrect counting, for example '97, 93'; a pause between numbers with a word interposed, for example '97 eh 94', or '97 eh 6', or '97, 90, 94'. The subjects knew that they were being recorded and so were motivated to make as few mistakes as possible, but in condition $B_3C_1$ (two distractors, cold water) subjects appeared to be distracted from their counting by the videotape, which they knew they would later be asked to recall (see Figure 15).

## DATA ANALYSIS

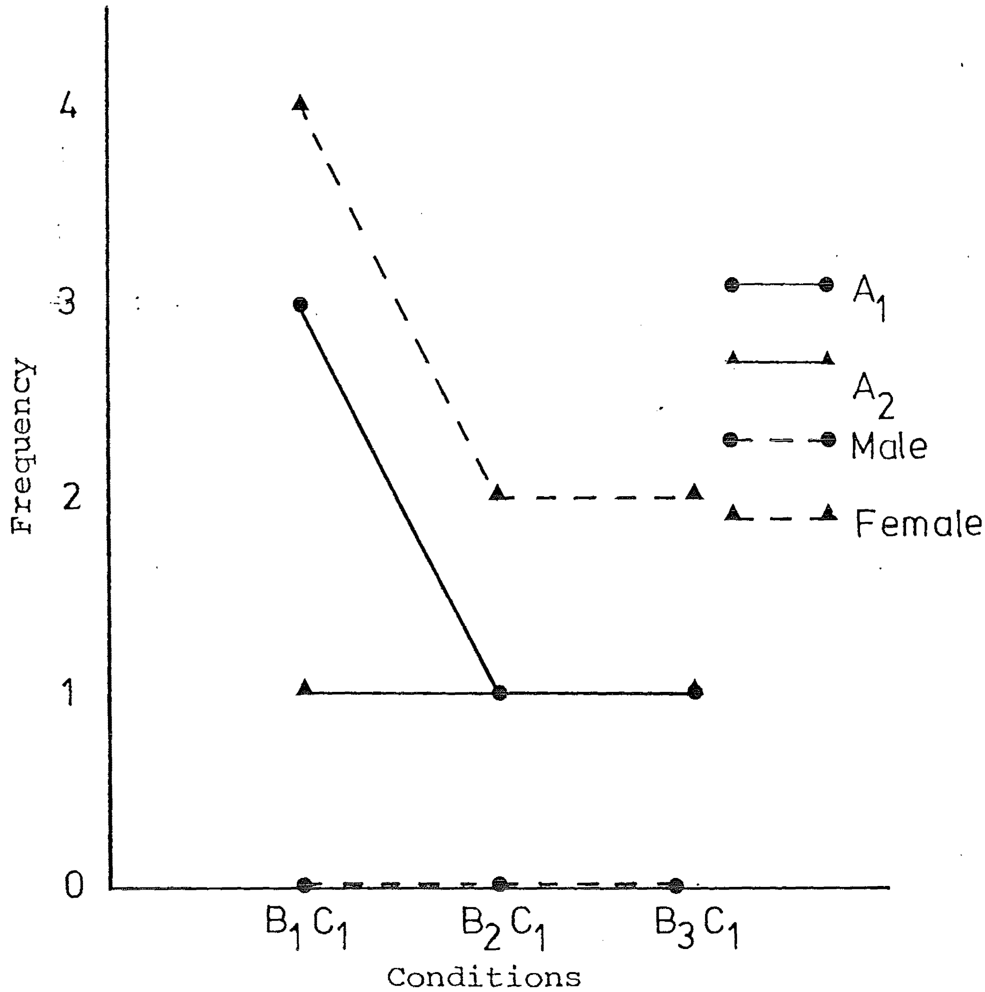
### 1. The number of withdrawals.

Figure 4. The total number of subjects withdrawing in each condition.




Though sex was not analysed as a separate variable, in several of the plots the data has been broken down by sex to show any trend for males to respond differently from females to the experimental setting. Therefore the male, female dichotomy is an alternative to the no knowledge, knowledge partitioning of the subjects. This information has been plotted on the same axes.

Figure 5. The number of withdrawals comparing male and female subjects and subjects in conditions $A_1$ and $A_2$.




Figures 4 and 5 show the decrease in the number of withdrawals as the number of distractors increases from zero to two (conditions $B_1$, $B_2$, and $B_3$) except for subjects in condition $A_2$ (knowledge) and for male subjects. As so few subjects withdrew any comments on these figures must be tentative.

The $A_1$ and $A_2$ (no knowledge and knowledge) conditions appear to have had some effect on whether or not the subject withdrew. Perhaps those subjects who knew that the experiment was about pain decided to endure the stimulus as long as possible, whereas those subjects who had no knowledge of the aim of the experiment were not so motivated. A similar motivation may also explain the difference between the male and female withdrawal rates. No males withdrew in any condition, perhaps because they wished to impress the female experimenter or because they were emulating the role of the 'strong male' who can withstand pain. Then again the results may merely reflect physiological response differences, although this seems unlikely.

An alternative explanation of the lack of withdrawals from the stimulus on the part of the subjects could be the effects of the experimental instructions. Previous experiments by Blitz and Dinnerstein (1968), Gelfand (1964), and Wolff and Horland (1967) have shown that varying the instructions can have an effect on both threshold and tolerance measures. The subjects in this experiment were instructed that "It is important to keep your hand in the water as long as you can so that I can compare the results of this session with the next one in which you will be monitoring a number of different stimuli". Such instructions could have provided sufficient motivation for the subject to continue to endure the stimulus for the maximum ten minutes.

In previous experiments subjects have been instructed to 'keep your hand in for as long as you possibly can' (Blitz and Dinnerstein, 1971 and Scott and Barber, 1977). In these studies Blitz and Dinnerstein found that two subjects out of a total of 36 subjects reached the four minute maximum imposed by the experimenters. In Scott and Barber's study 60% of the subjects in one condition and 62% of the subjects in another condition reached the three minute tolerance limit.

These results are in contrast to those of Brown, Fader, and Barber (1973) who found that on average subjects removed their hand from the stimulus after 85 seconds exposure. Davidson and McDougall (1969) have further pointed out that in most studies using the cold pressor test the data is skewed, often very badly, with a number of very extreme scores. Davidson and McDougall themselves, using a 12 minute tolerance limit, obtained highly positively skewed data, though not as badly skewed as in most other studies. They attributed the shorter tolerance limits to the fact that the ice water was kept well below $5^{\circ}C$, however the water temperature in most experiments is kept well below $5^{\circ}C$, usually it is kept at approximately $1^{\circ}C$, so this factor alone cannot account for the variability of individual reaction to the cold pressor test. Perhaps a large part of the individual variation in response may be due to physiological factors such as the Lewis effect mentioned in Kanfer and Goldfoot (1966).

It would seem most likely that a combination of physiological and psychological factors such as the experimental setting and instructions result in the marked variation of individual responses to the cold pressor test.

2. <u>The time of withdrawal</u>.

Table 1. The means and standard deviations of time of withdrawal (in seconds) in each condition.

| | | $B_1$ | $B_2$ | $B_3$ |
|---|---|---|---|---|
| $A_1$ | $\bar{X}$ | 482.50 | 508.33 | 509.66 |
| | $s^2$ | 198.009 | 204.973 | 201.992 |
| $A_2$ | $\bar{X}$ | 543.33 | 597.50 | 562.50 |
| | $s^2$ | 126.711 | 5.59017 | 83.8526 |

Figure 6. The mean time of withdrawal (in seconds) comparing male and female subjects and subjects in conditions $A_1$ and $A_2$.

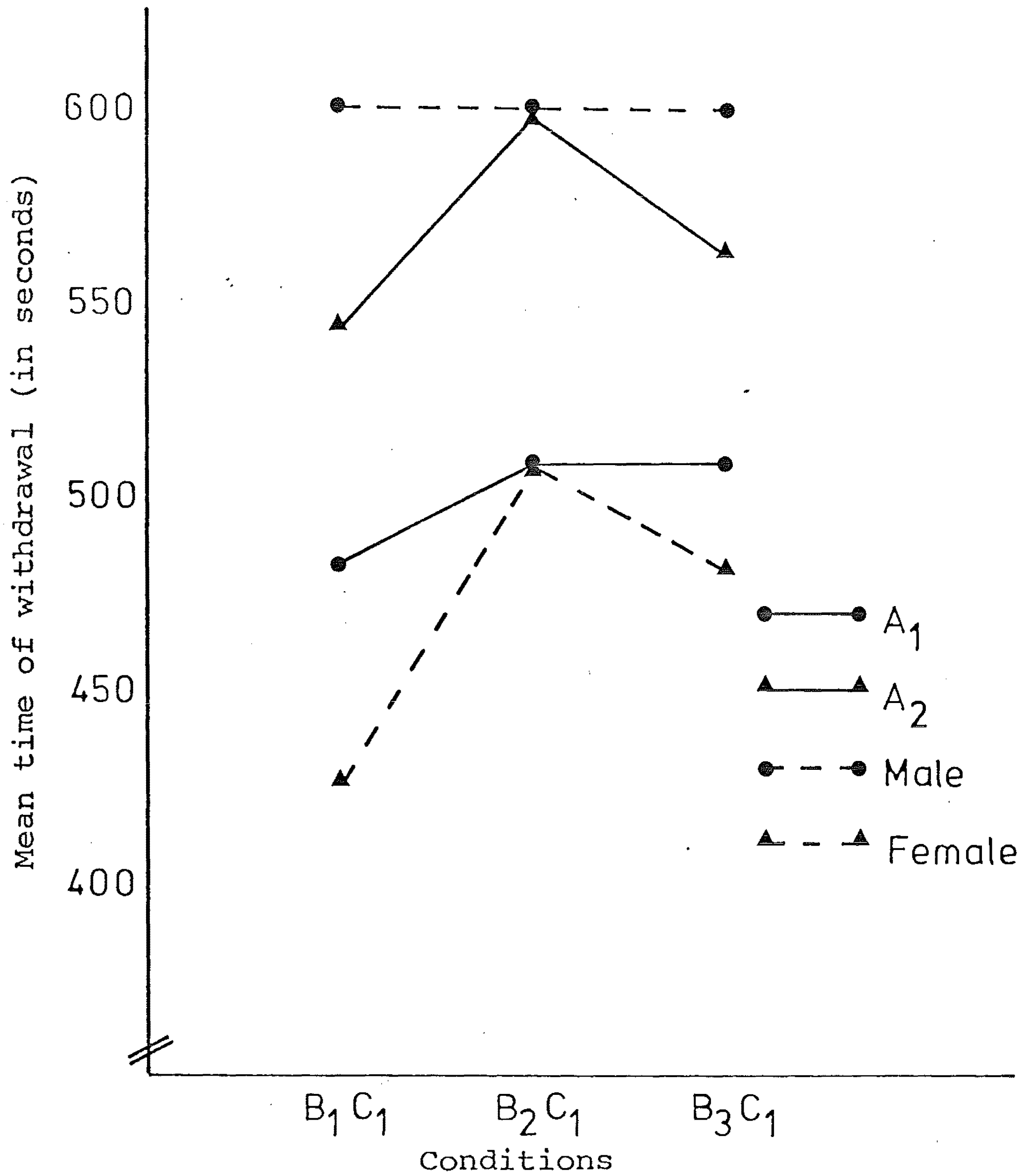



Figure 6 shows the mean time of withdrawal, in seconds, for male and female subjects and subjects in conditions $A_1$ (no knowledge) and $A_2$ (knowledge). By comparing the time of withdrawal for these subjects it can be seen that no male subjects withdrew from the stimulus (600 seconds was the maximum time limit).

There would appear to be very little relationship between mean time of withdrawal and the number of distractors presented to the subject, except that subjects in condition $B_1C_1$ (no distractor, cold water) tended to have the lowest mean time of withdrawal, and subjects in condition $B_2C_1$ (one distractor, cold water) tended to have the highest mean time of withdrawal. This did not confirm the second experimental hypothesis which predicts that subjects in condition $B_3C_1$ (two distractors, cold water) would have the highest mean time of withdrawal. The main reason for this would appear to be the large degree of individual variability in time of withdrawal; many of the subjects endured stimulation for the maximum time permitted and a few subjects withdrew from the stimulus after a very short time, for example 50 seconds.

The first experimental hypothesis, which states that knowledge of the aim of the experiment will increase the subjects' tolerance levels, did receive a measure of support. Subjects in condition $A_2$ (knowledge) had a higher mean withdrawal time in all conditions, $B_1$, $B_2$, and $B_3$, than did subjects in condition $A_1$ (no knowledge). However these findings can only be tentative, because of the extreme variability of individual withdrawal times.

TABLE 2

ANOVA SUMMARY TABLE

| Source | SS | df | MS | F |
|---|---|---|---|---|
| A | 15123.00 | 1 | 15123.00 | 0.5845 |
| R(A) | 258742.5 | 10 | 25874.25 | |
| B | 850.0833 | 1 | 850.0833 | 0.7807 |
| AB | 990.0833 | 1 | 990.0833 | 0.9093 |
| RB(A) | 10888.33 | 10 | 1088.833 | |
| C | 36963.00 | 1 | 36963.00 | 1.4286 |
| AC | 15123.00 | 1 | 15123.00 | 0.5845 |
| RC(A) | 258742.5 | 10 | 25874.25 | |
| ABC | 990.0833 | 1 | 990.0833 | 0.9093 |
| RBC(A) | 10888.33 | 10 | 1088.833 | |

$F_A(1,10) = 0.5845 < F_{.95}(1,10) = 4.96$ NS

$F_B(1,10) = 0.7807 < F_{.95}(1,10) = 4.96$ NS

$F_C(1,10) = 1.4286 < F_{.95}(1,10) = 4.96$ NS

$F_{AB}(1,10) = 0.9093 < F_{.95}(1,10) = 4.96$ NS

$F_{AC}(1,10) = 0.5845 < F_{.95}(1,10) = 4.96$ NS

$F_{ABC}(1,10) = 0.9093 < F_{.95}(1,10) = 4.96$ NS

TABLE 3

ANOVA SUMMARY TABLE

| Source | SS | df | MS | F |
|---|---|---|---|---|
| A | 41141.36 | 1 | 41141.36 | 0.5064 |
| R(A) | 812380.9 | 10 | 81238.09 | |
| B | 9680.222 | 2 | 4840.111 | 1.6498 |
| AB | 2186.889 | 2 | 1093.441 | 0.3727 |
| RB(A) | 58673.56 | 20 | 2933.678 | |

$F_A(1,10) = 0.5064 < F_{.95}(1,10) = 4.96$ NS

$F_B(2,20) = 1.6498 < F_{.95}(2,20) = 3.49$ NS

$F_{AB}(2,20) = 0.3727 < F_{.95}(2,20) = 3.49$ NS

Tables 2 and 3 present the analyses of variance performed on the data. The A,B, and C main effects were found to be non significant, as were the AB, AC, and ABC interaction effects.

3. <u>The number of 'requests out'</u>.

Figure 7. The total number of 'requests out' in each condition.

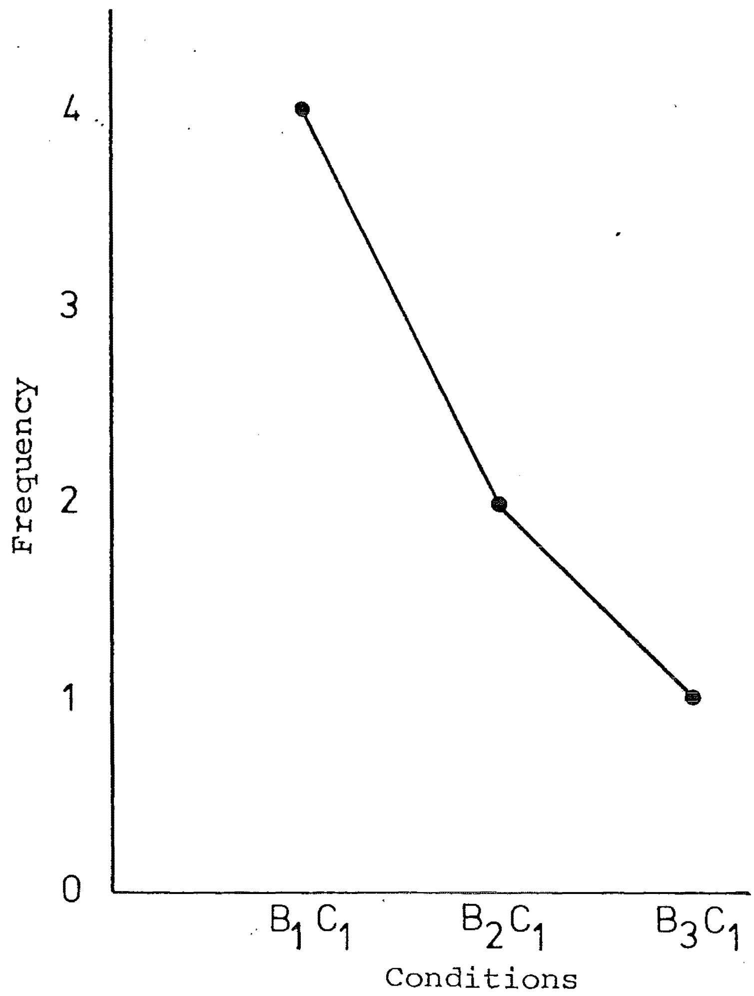


Figure 8. The number of 'requests out' comparing the results of male and female subjects and subjects in conditions $A_1$ and $A_2$.

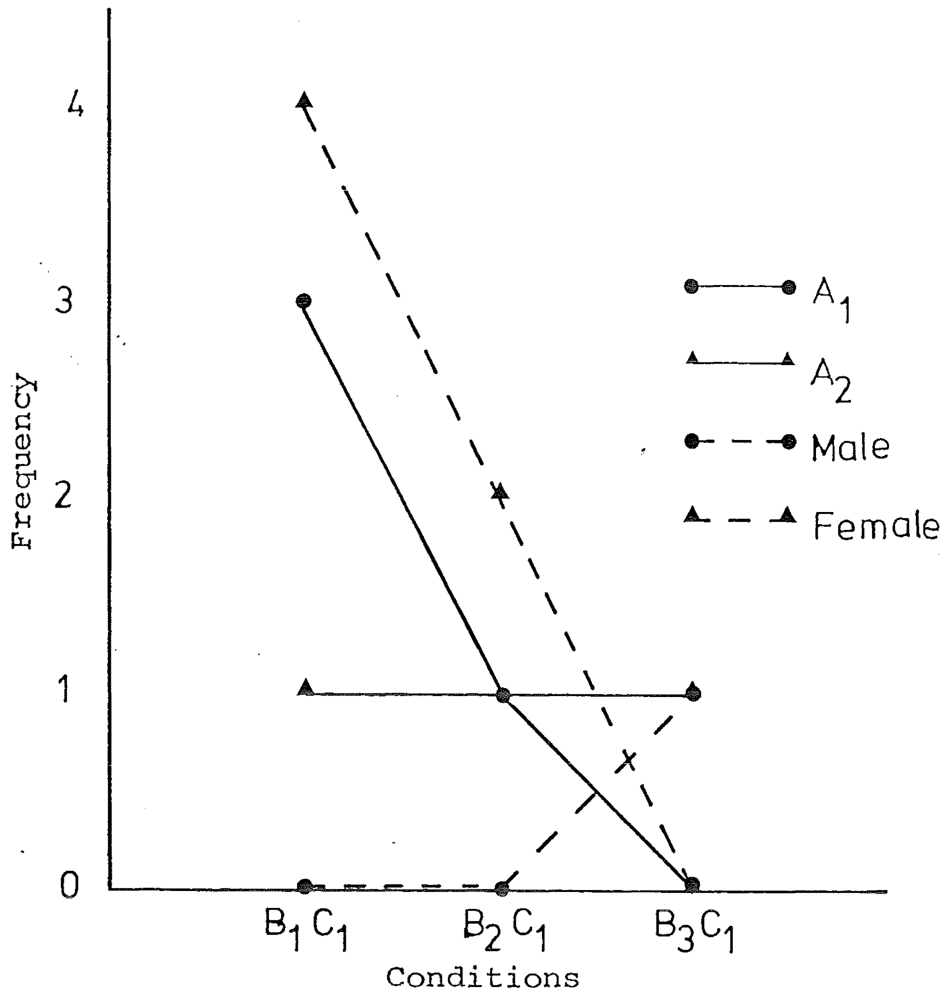



Figure 7 illustrates the trend for the number of 'requests out' to decrease as the number of distractors increases thus lending support to the second experimental hypothesis, although there is still a problem with the individual variability of response (see figure 8).

Figure 8 demonstrates the differences between male and female subjects (only one male subject 'requested out', whereas a number of female subjects 'requested out').

Figure 8 also shows the differences between subjects in conditions $A_1$ (no knowledge) and $A_2$ (knowledge). Subjects in condition $A_1$ tended to 'request out' more often than subjects in condition $A_2$, thus giving some support to the first experimental hypothesis. The number of subjects 'requesting out' was small (a number of subjects withdrew without first 'requesting out') with a number of empty cells. As a result no further analysis was carried out on the data so any support for the experimental hypotheses is only suggestive.

4. The total number of comments.

Table 4. Means and standard deviations of the number of comments made by subjects in each condition.

| | | $B_1$ | $B_2$ | $B_3$ |
|---|---|---|---|---|
| $A_1$ | $\bar{X}$ | 14.5 | 6.83333 | 3.83333 |
| | $s^2$ | 9.10586 | 2.40974 | 1.34371 |
| $A_2$ | $\bar{X}$ | 10.5 | 6.66667 | 6.66667 |
| | $s^2$ | 7.04154 | 3.59011 | 1.37437 |

Figure 9. The mean number of comments made by subjects comparing male and female subjects and subjects in conditions $A_1$ and $A_2$.

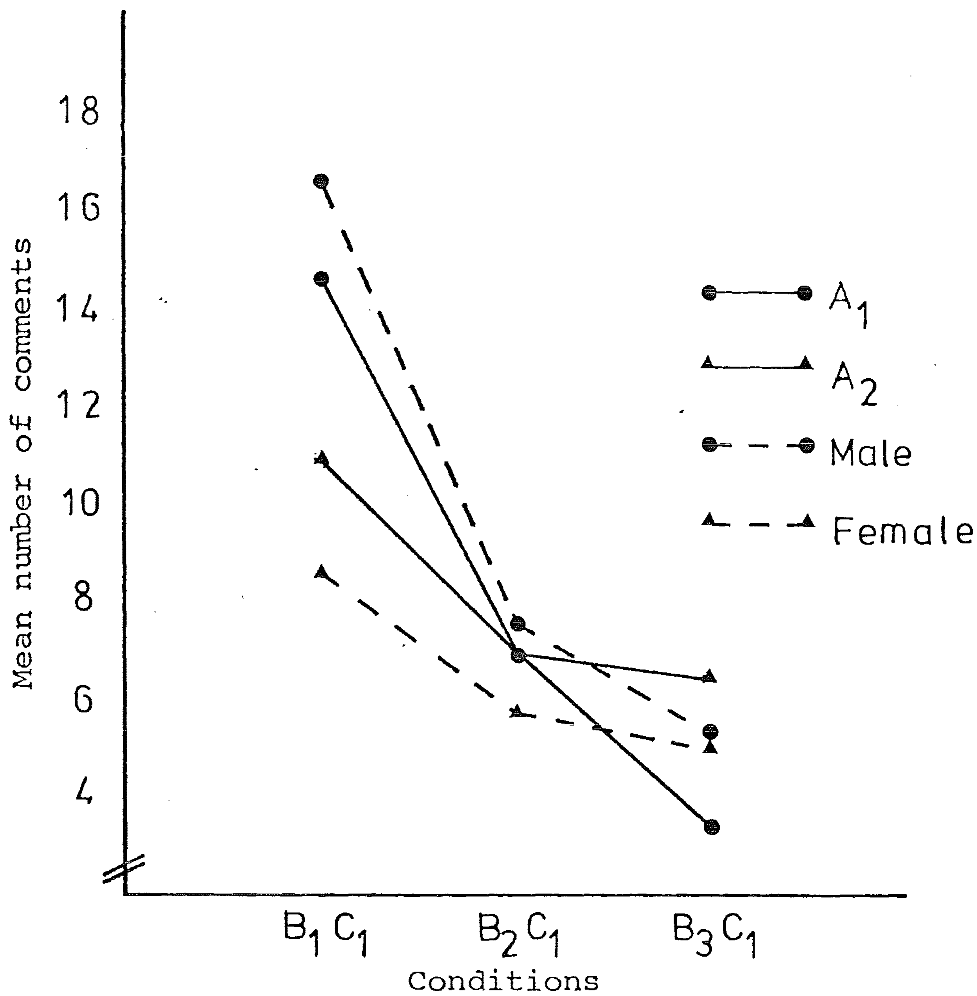



Figure 9 shows the decrease in the mean number of comments, by all subjects, in the $A_1$ (no knowledge) and $A_2$ (knowledge) conditions and by male and female subjects, as the number of distractors increase. This supports the second experimental hypothesis. The decrease in the mean number of comments could be accounted for by the effectiveness of the distractors which led the subjects to pay less attention to the sensations in their hands. The subjects concentrated less on their hands as they knew that their counting backwards, (which some subjects found a difficult task requiring a great deal of concentration) was being monitored.

The decrease in the mean number of comments was larger between conditions $B_1C_1$ (no distractor, cold water) and $B_2C_1$ (one distractor, cold water) than between conditions $B_2C_1$ and $B_3C_1$ (two distractors, cold water). As a result the decrease can be said to be the result of the effectiveness of the distractors. The decrease does not appear to be the result of the subject having so much to say, in condition $B_3C_1$, with the backwards counting, that he or she had no time to comment on his or her hand. It also demonstrates, at least with the distractors used in this experiment, that two distractors are not greatly more effective than one distractor.

TABLE 5

ANOVA SUMMARY TABLE

| Source | SS | df | MS | F |
|---|---|---|---|---|
| A | 2.250000 | 1 | 2.250000 | 0.0449 |
| R(A) | 501.3889 | 10 | 50.13889 | |
| B | 357.3889 | 2 | 178.6944 | 7.8759 |
| AB | 73.50000 | 2 | 36.75000 | 1.6197 |
| RB(A) | 453.7778 | 20 | 22.688889 | |

$F_A(1,10) = 0.0449 < F_{.95}(1,10) = 4.96$ NS

$F_B(2,20) = 7.8759 > F_{.99}(2,20) = 5.85$ p .01

$F_{AB}(2,20) = 1.6197 < F_{.95}(2,20) = 4.96$ NS

The analysis of variance summarized in table 5 shows that the B main effect is significant at the .01 level indicating that the changes in the number of distractors produced a change in the mean number of comments made by subjects on the sensations they felt in their hands. The A main effect and the AB interaction were found to be non significant.

TABLE 6

T-test (repeated measures) of differences between means for $B_1$ (no distractors), $B_2$ (one distractor), and $B_3$ (two distractors)

| | Number of distractors | | |
|---|---|---|---|
| | $B_1$ versus $B_2$ | $B_1$ versus $B_3$ | $B_2$ versus $B_3$ |
| t | 2.81193 | 2.73836 | 1.80839 |
| p | .01 | .025 | .05 NS |

The figures presented in table 6 support the results shown in figure 9 demonstrating that there is a significant difference between the mean number of comments made by subjects in conditions $B_1C_1$ (no distractor, cold water) and $B_2C_1$ (one distractor, cold water). The difference between $B_2C_1$ and $B_3C_1$ (two distractors, cold water) just fails to reach significance.

5. The time of first comment.

Table 7. The means and standard deviations of the time of first comment (in seconds) made by the subjects.

| | | $B_1$ | $B_2$ | $B_3$ |
|---|---|---|---|---|
| $A_1$ | $\bar{X}$ | 20.8333 | 23.6667 | 49.3333 |
| | $s^2$ | 11.1567 | 33.2499 | 64.4662 |
| $A_2$ | $\bar{X}$ | 104.167 | 104.833 | 71.3333 |
| | $s^2$ | 142.419 | 136.078 | 126.641 |

Figure 10. The time of first comment (in seconds) comparing the results of male and female subjects and subjects in conditions $A_1$ and $A_2$.

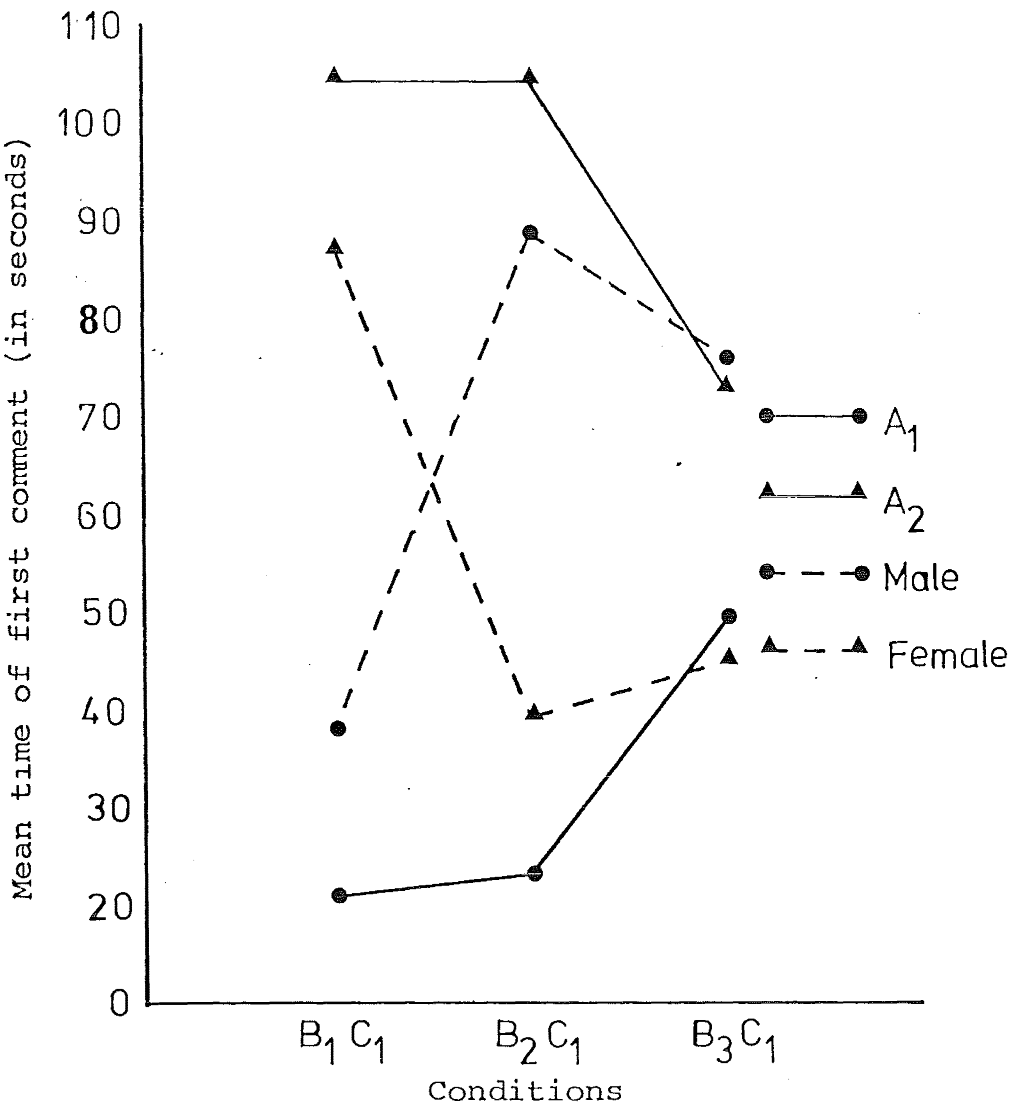



Figure 10 presents a comparison of means for the time of first comment. According to the second experimental hypothesis the time until first comment should increase as the number of distractors increases, however as figure 10 demonstrates this did not occur [or only occurred for one group of subjects, those in condition $A_1$ (no knowledge)].

There were a number of problems with this measure, aside from the extreme variability of the subjects' score. Subjects were not asked to comment when it first hurt as it was reasoned that this would destroy the $A_1$ (no knowledge) condition, so the first complaint of pain, discomfort, unpleasantness, or soreness was recorded. This led to problems as each subject apparently had a different conception of exactly what 'discomfort', 'pain', 'soreness', and 'unpleasantness' were. Some subjects seldom if ever used the word pain, and others rated discomfort as more painful than unpleasant and vice versa, or they rated soreness as more painful than discomfort or unpleasantness. Certain subjects did not comment on sensations that they felt in their hand for some considerable time, for example 394 seconds. Perhaps because the instructions were not stressed enough and subjects got so involved in watching the videotape or counting backwards that they forgot, at least for a time, to state how their hands felt. Other subjects commented on the sensations in their hands very quickly, for example six seconds. So there was a very wide range of times in this dependent variable with the extreme scores, for example 411, 394, and 353 seconds, skewing the data.

TABLE 8

ANOVA SUMMARY TABLE

| Source | SS | df | MS | F |
|---|---|---|---|---|
| A | 35406.69 | 1 | 35406.69 | 1.6835 |
| R(A) | 210321.6 | 10 | 21032.16 | |
| B | 57.38889 | 2 | 28.69444 | 0.0038 |
| AB | 6871.056 | 2 | 3435.528 | 0.4589 |
| RB(A) | 149739.6 | 20 | 7486.978 | |

$F_A(1,10) = 1.6835 < F_{.95}(1,10) = 4.96$ NS

$F_B(2,20) = 0.0038 < F_{.95}(2,20) = 3.49$ NS

$F_{AB}(2,20) = 0.4589 < F_{.95}(2,20) = 3.49$ NS

Table 8 presents an analysis of variance performed on the data. The A and B main effects and the AB interaction are all non significant.

6. The number of points remembered.

Table 9. The means and standard deviations of the number of points remembered by the subjects.

| | | $B_1$ | $B_2$ | $B_3$ |
|---|---|---|---|---|
| $A_1$ | $\bar{X}$ | 43.8333 | 23.6667 | 24.1667 |
| | $s^2$ | 35.362 | 13.4495 | 23.205 |
| $A_2$ | $\bar{X}$ | 44.8333 | 25.000 | 49.8333 |
| | $s^2$ | 26.0731 | 12.4499 | 40.9448 |

Figure 11. The mean number of points remembered comparing the results of subjects in conditions $B_2C_1$ and $B_2C_2$.

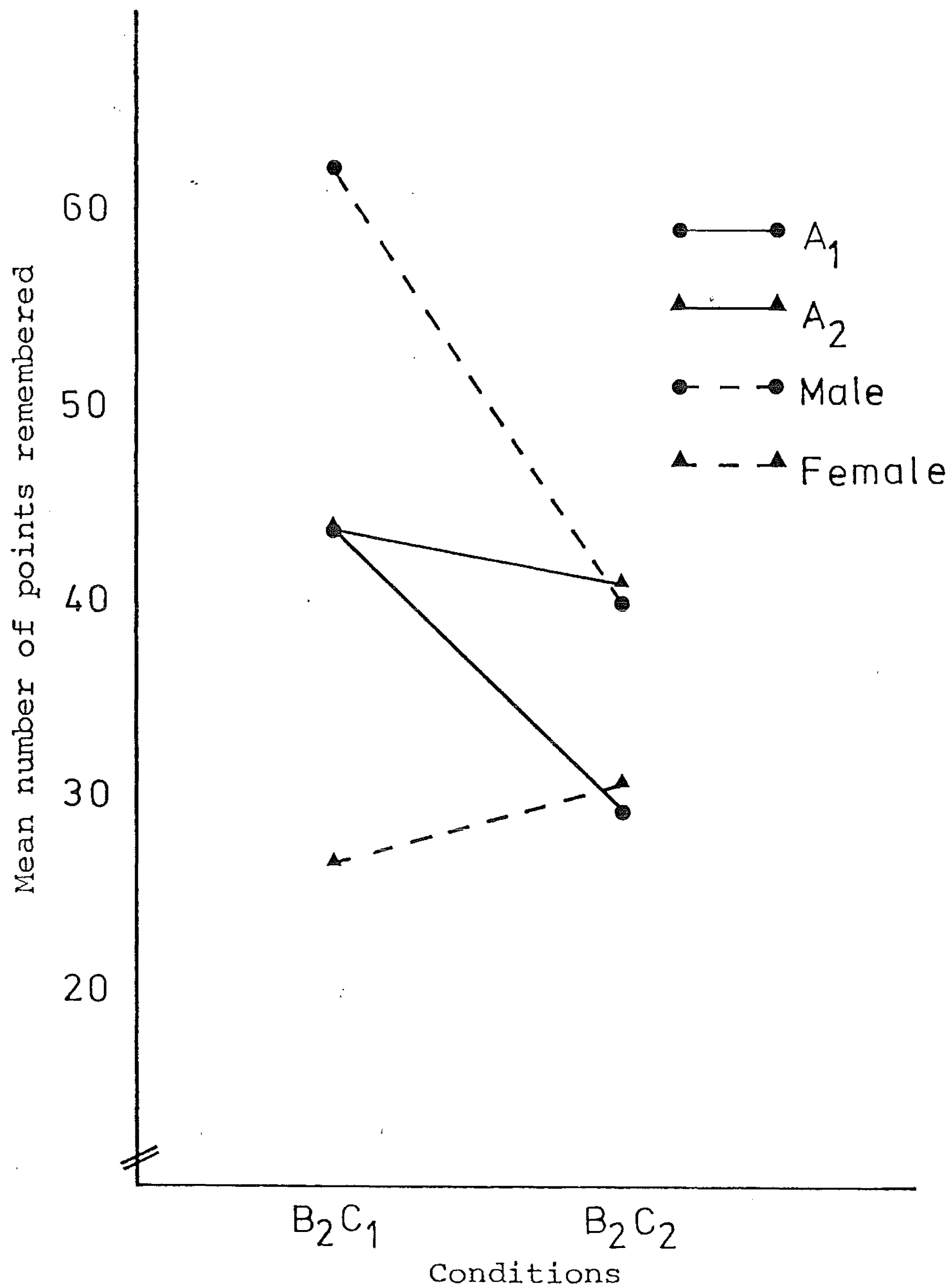
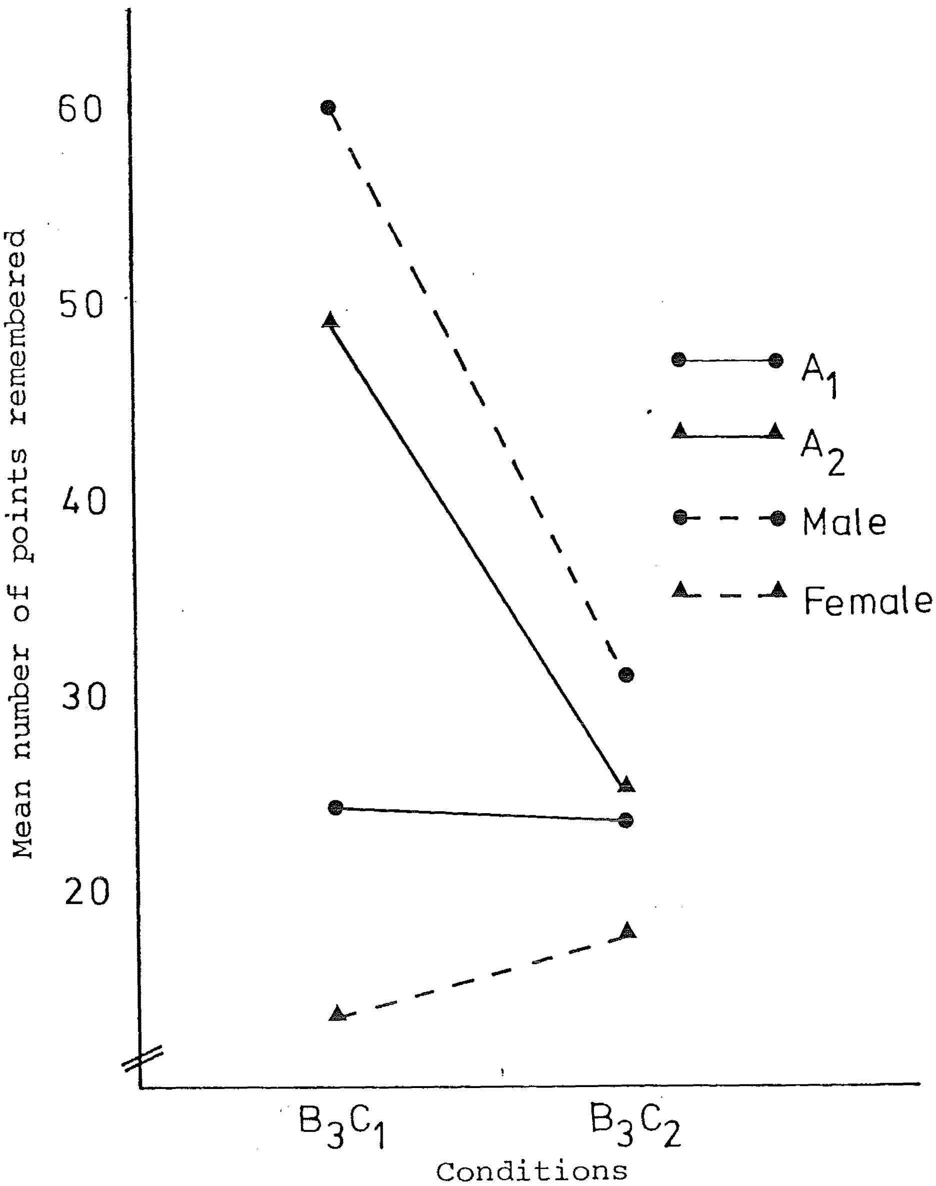


Figure 12. The mean number of points remembered comparing the results of subjects in conditions $B_3C_1$ and $B_3C_2$.




Figures 11 and 12 both show a decrease in the mean number of points remembered from the videotape from the $C_1$ (cold water) to the $C_2$ (warm water) conditions, although in both graphs the female subjects, unlike the male subjects, show a small increase in the mean number of points remembered. This decrease from $C_1$ to $C_2$ conditions could be due to the necessity to concentrate harder on the videotape, and thus remember more, in the $C_1$ conditions in order to distract the subject's mind from his or her hand. The data suggest that in the $C_2$ conditions, the subjects relaxed and did not concentrate as hard and therefore remembered less.

The increase in the mean number of points remembered on the part of the female subjects is, like the increase shown by subjects in the $A_2$ (knowledge) condition in figure 13, difficult to explain. It may be that the female subjects found the $C_1$ conditions more stressful and this interfered with their concentration or memory while the $C_2$ conditions, which were not stressful, allowed them to concentrate more fully on the videotape and hence remember more of the videotape.

Figure 13. The mean number of points remembered comparing the results of subjects in conditions $B_2C_1$ and $B_3C_1$.

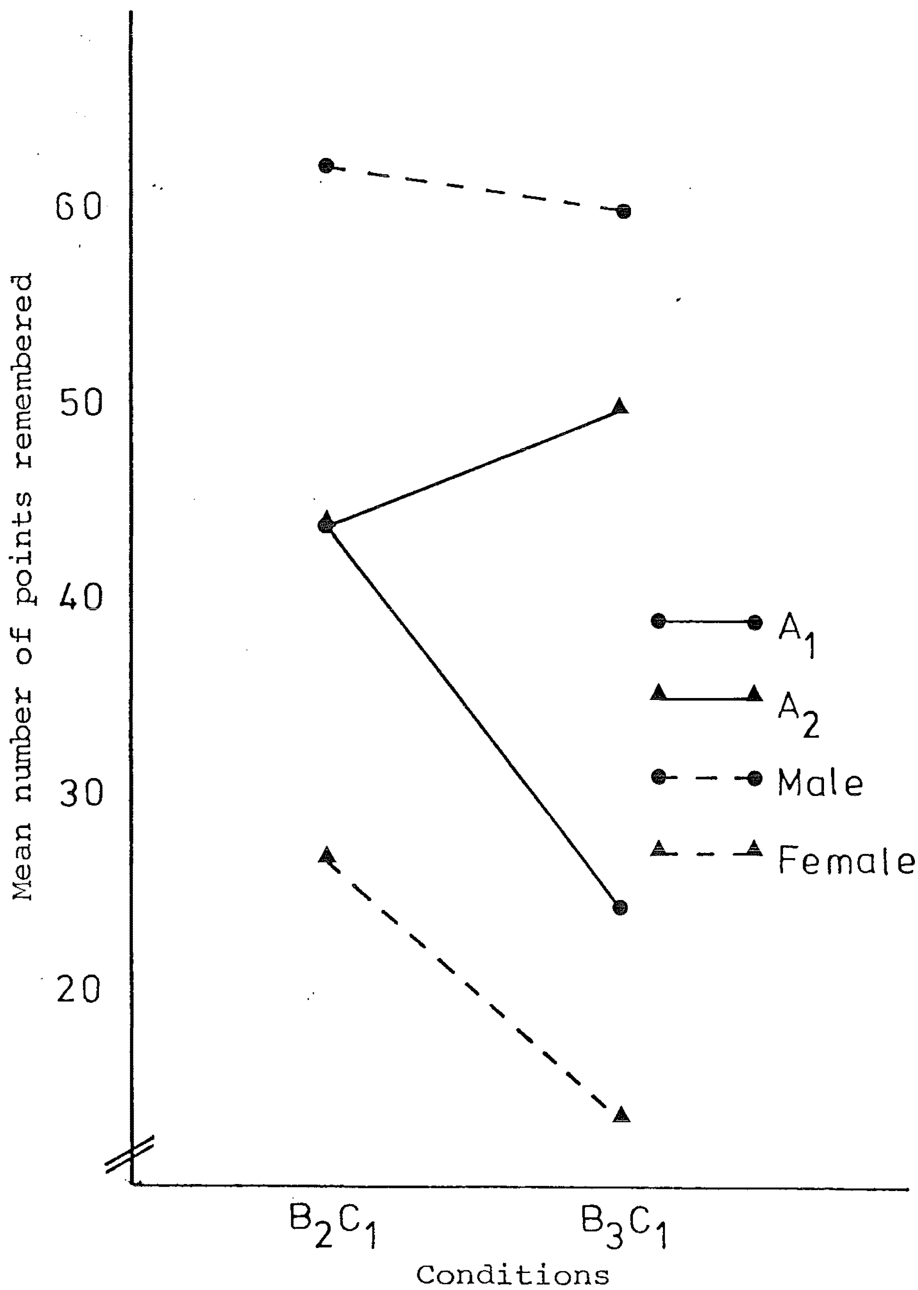


Figure 14. The mean number of points remembered comparing the results of subjects in conditions $B_2C_2$ and $B_3C_2$.

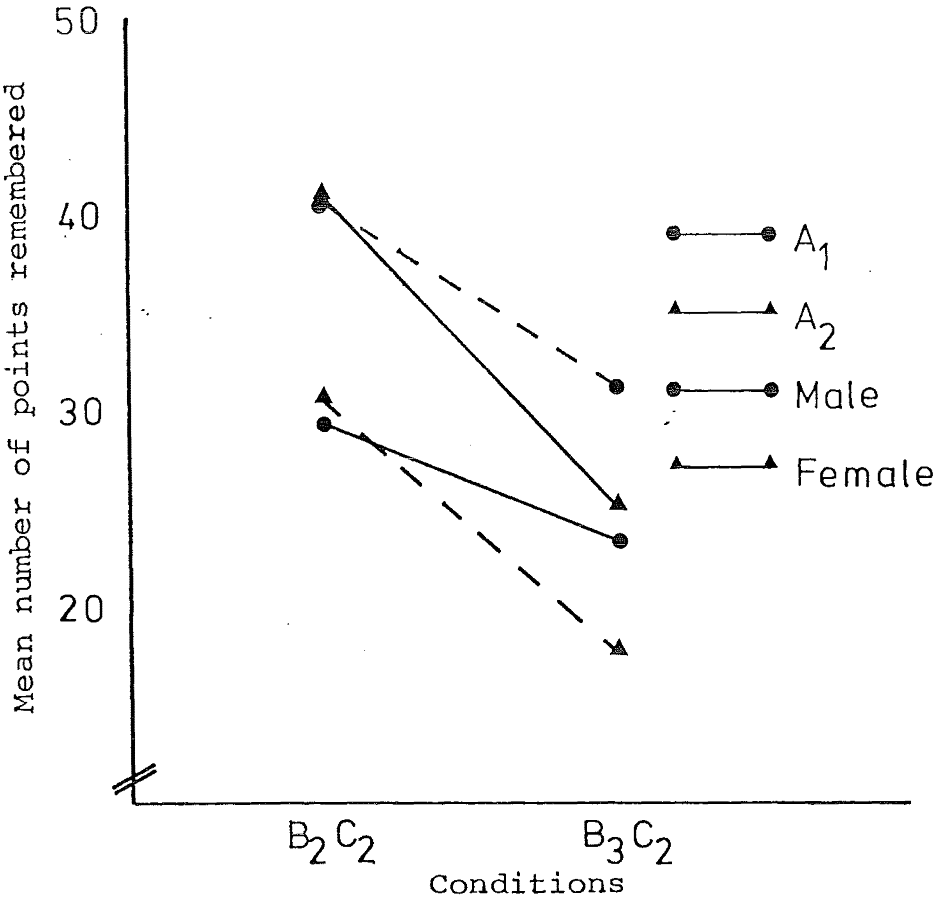



Figure 13 shows that there is a decrease, for three groups of subjects, in the mean number of points remembered in conditions $B_2C_1$ (one distractor, cold water) and $B_3C_1$ (two distractors, cold water). This decrease could be due to the effect of the counting backwards, which a number of subjects stated distracted them from the videotape. Subjects felt that they had to make a choice between either watching the videotape or counting backwards. As the counting backwards was done out loud, subjects may have felt more pressure to concentrate on the counting as it was immediately obvious when subjects either were not counting or were making errors in their counting. To that extent, these results do not offer any additional support for the second experimental hypothesis which states that as the number of distractors increases tolerance level increases. It appears that the two distractors used in this experiment worked to some extent against each other; if the subject concentrated on one he or she could not concentrate on the other distractor.

Comparison of figures 13 and 14 shows additional support for this view as subjects in conditions $B_2C_2$ (one distractor, warm water) and $B_3C_2$ (two distractors, warm water) also remembered less of the videotape when the two distractors were presented.

From the results it can also be seen that there was a problem with individual variability of scores, with certain subjects apparently having better memories than others, although this effect was more marked in the $C_1$ (cold water) conditions. So the results may also reflect individual subjects differing in the ability to utilize the distractors effectively by concentrating on them to the exclusion of the sensations they could feel in their hands.

TABLE 10

ANOVA SUMMARY TABLE

| Source | SS | df | MS | F |
|---|---|---|---|---|
| A | 1160.333 | 1 | 1160.333 | 0.6041 |
| R(A) | 19209.17 | 10 | 1920.917 | |
| B | 1008.333 | 1 | 1008.333 | 2.6904 |
| AB | 161.3333 | 1 | 161.3333 | 0.4305 |
| RB(A) | 3747.833 | 10 | 374.7833 | |
| C | 1408.333 | 1 | 1408.333 | 2.1888 |
| AC | 147.0000 | 1 | 147.0000 | 0.2285 |
| RC(A) | 6434.167 | 10 | 643.4167 | |
| ABC | 901.3333 | 1 | 901.3333 | 3.0258 |
| RBC(A) | 2978.833 | 10 | 297.8833 | |

$F_A(1,10) = 0.6041 < F_{.95}(1,10) = 4.96$ NS

$F_B(1,10) = 2.6904 < F_{.95}(1,10) = 4.96$ NS

$F_C(1,10) = 2.1888 < F_{.95}(1,10) = 4.96$ NS

$F_{AB}(1,10) = 0.4305 < F_{.95}(1,10) = 4.96$ NS

$F_{AC}(1,10) = 0.2285 < F_{.95}(1,10) = 4.96$ NS

$F_{ABC}(1,10) = 3.0258 < F_{.95}(1,10) = 4.96$ NS

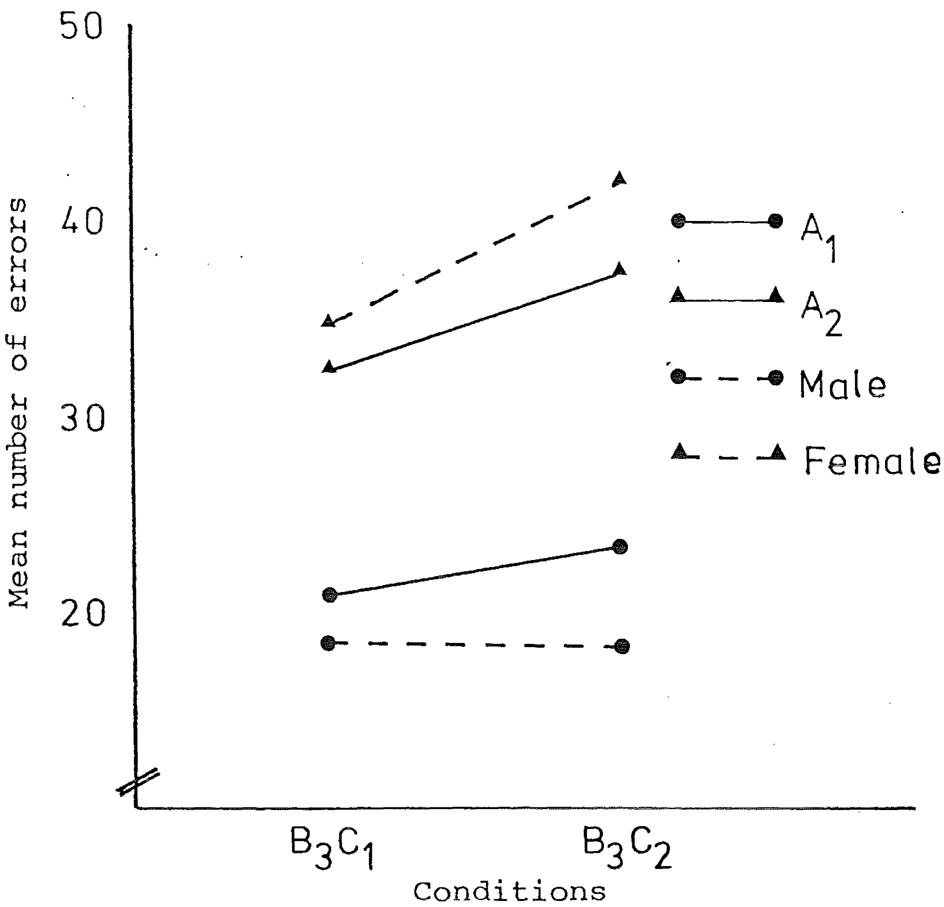
The main effects A, B, and C and the interactions AB, AC, and ABC presented in table 10 are all non significant.

## 7. The number of errors in backwards counting.

Table 11. The means and standard deviations of the mean number of errors made in backwards counting.

| | | $B_3C_1$ | $B_3C_2$ |
|---|---|---|---|
| $A_1$ | $\bar{X}$ | 23.6667 | 21.0000 |
| | $s^2$ | 18.1261 | 15.5778 |
| $A_2$ | $\bar{X}$ | 37.5000 | 32.3333 |
| | $s^2$ | 29.9819 | 32.4226 |

Figure 15. The mean number of errors made in backwards counting comparing the results of male and female subjects and subjects in conditions $A_1$ and $A_2$.




The mean number of errors made in the backwards counting increased between conditions $C_1$ (cold water) and $C_2$ (warm water). This lends additional support to figures 11 to 14. It would appear that subjects in condition $C_1$ need to, or choose to, concentrate much harder on the distractors in order to distract their attention from their hands so they make less errors in the backwards counting and remember more of the videotapes. This view was also supported by some of the subjects' comments. They stated that the videotape and counting backwards did distract them from the pain and they did try to concentrate very hard on the videotape, although as one subject pointed out the coldness got in the way.

TABLE 12

ANOVA SUMMARY TABLE

| Source | SS | df | MS | F |
|---|---|---|---|---|
| A | 950.0417 | 1 | 950.0417 | 0.7536 |
| R(A) | 12606.08 | 10 | 1260.608 | |
| C | 92.04167 | 1 | 92.04167 | 0.3649 |
| AC | 9.375000 | 1 | 9.375000 | 0.0372 |
| RC(A) | 2522.083 | 10 | 252.2083 | |

$F_A(1,10) = 0.7536 \quad F_{.95}(1,10) = 4.96$ NS

$F_C(1,10) = 0.3649 \quad F_{.95}(1,10) = 4.96$ NS

$F_{AC}(1,10) = 0.0372 \quad F_{.95}(1,10) = 4.96$ NS

The A and C main effects were non significant, as was the AC interaction. The non significant results in the analysis of variance indicate that although certain trends, as shown in table 11 and figure 15, are present these are non significant, perhaps because of the large individual variability or insufficiently strong experimental manipulations. The subjects' comments lend support to the trends shown in these graphs. Their comments show that most subjects found the distractors to be effective in taking their minds off the pain. Some subjects further commented that the distractors actually reduced the pain.

# CHAPTER V

## DISCUSSION OF RESULTS AND CONCLUSIONS

### DISCUSSION OF RESULTS

The degree of individual variability has been a major problem in this study. Previous experimenters, as Davidson and McDougall (1969) point out, have also had similar problems, which may be due to the nature of the cold pressor test rather than due to lack of experimental control.

Experimental control in such experiments however is problematic as there are so many variables to be controlled. These include the physical setting itself, the experimental design and instructions, and both physiological and psychological variables attributable to the particular experimenter and subject involved.

In this study the physical setting was kept as plain as possible (see Figure 3), yet subjects still managed to use features of the experimental room as distractors, or to devise their own distractors by tapping their feet, moving their hands or bodies, relaxing, ignoring the pain, or daydreaming. By this reasoning condition $B_1C_1$ (no distractors, cold water) did actually have distractors present. Therefore comparisons between conditions $B_1$ (no distractors), $B_2$ (one distractor), and $B_3$ (two distractors) were actually between subject- and experimenter-provided distractors. However it is extremely difficult, if not impossible, to control the subjects' use of various features of the experimental room as distractors and even if subjects do not use features of the experimental room as distractors they cannot be prevented from using their imaginations to provide distractors.

There were problems with the experimental design, especially with setting up the $A_1$ (no knowledge) and $A_2$ (knowledge) conditions. It was difficult to devise instructions which would satisfactorily mask the true aim of the experiment and yet still yield suitable dependent variables to measure the effects of the experimental manipulation. Most subjects in this condition accepted the instructions as given. They thought, when questioned after the experiment, that the experiment was a test of concentration, recall, or ability to cope with a number of different stimuli. At least two subjects, however, deduced that the experiment was to test the effects of distractors on pain experience.

The $A_1$, $A_2$ conditions were the main reason no threshold (or as phrased in this study, first comment by the subjects of pain, discomfort, soreness, or unpleasantness) measures were obtained. It would be expected however that distractors would not have such a marked effect on threshold as on tolerance measures.

The experimental instructions, largely arranged to establish the $A_1$ and $A_2$ (no knowledge and knowledge) conditions may also have been a source of the individual variability observed in responses. Subjects were instructed that 'It is important to keep your hand immersed until the videotape is finished so that you are monitoring all the stimuli throughout the session'. This instruction, allied with the social aspects of the experiment: the experimenter was female and society has expectations of endurance and strength of the part of males: may thus have created pressures that were sufficient to cause male subjects to raise their tolerance levels as measured by the number of withdrawals, time of withdrawal, and more indirectly by the number of 'requests out'. This would not be expected to affect the tolerance level of the female subjects to such a large extent. This is supported by the trend in the data shown in figures 5, 6, and 8 where the number of female subjects who withdrew or 'requested out' was greater than the number of male subjects who withdrew or 'requested out'.

The subject him or herself was also a major source of variability. His or her physiology would partly determine the sensations felt, and so affect threshold and tolerance levels. Of more importance are the subject's psychological attributes. These attributes include his or her ability to devise his or her own distractors, the ability to concentrate on one or more distractors to exclude painful sensations, his or her expectations of the behaviour expected by the experimenter during the experiment, and the subject's interpretation of the experimental instructions, of the words pain, unpleasant, uncomfortable, and sore. All of these factors would affect the experimental results and they are very difficult to control. It is difficult to see how an experiment can be carried out without the subject having certain expectations caused by the type of experiment, the setting, the experimenter, and the experimenter's instructions and behaviour. In this field of research these expectations can have important effects on the experimental results.

All of the factors listed above increase subject variability and, in this experiment, increase the extent to which the effects of the experimental manipulation were masked, but the lack of significant results could be due to the weakness of the experimental manipulations. However there does seem to be a trend present in the data, though largely non significant, which supports the results of previous experiments, such as those by Barber and Cooper (1972), who used the Forgione-Barber stimulator, Kanfer and Goldfoot (1966), who used ice water, and

Spanos, Horton, and Chaves (1975), who also used ice water.

The results of these experiments suggest that the experimental manipulations themselves are not the reason for the non significance of the results, but the lack of experimental control of peripheral factors, though the significance of the results could have been enhanced by a larger subject sample.

## CONCLUSION

Future studies should perhaps attempt to establish more experimental control, by manipulating the experimental setting and instructions and the experimenter him or herself, while examining the effect of various distractors. It is important to discover effective distractors including those the subject can gain access to without great expenditure or training and can use in his or her home. Along these lines the use of videotapes, which are similar to the television or the movies, should be further examined not only with different types of experimental pain, but also clinical pain. More research needs to be done on the effect of distractors which require overt participation on the part of the subject (in this experiment counting backwards), such as reading, conversing with someone, learning various tasks and so on.

Research into the cognitive control of pain is relatively recent and it requires a great deal more study to establish effective and reliable measures of pain. Only when these are achieved, will it be possible to search for effective and reliable measures of pain relief.

REFERENCES

Afifi, A. A. and Azen, S. P. Statistical Analysis: A computer oriented approach. New York: Academic Press, 1972.

Bandler, R. J. Jr., Madaras, G. R., and Bem, D. J. Self-observation as a source of pain perception. Journal of Personality and Social Psychology, 1968, 9, 205-209.

Barber, T. X. and Calverley, D. S. 'Hypnotic' behaviour as a function of task motivation. Journal of Psychology, 1962, 54, 363-389.

Barber, T. X. and Cooper, B. J. Effects on pain of experimentally induced and spontaneous distraction. Psychological Reports, 1972, 31, 647-651.

Barber, T. X. and Hahn, K. W. Physiological and subjective responses to pain producing stimulation under hypnotically-suggested and waking-imagined 'analgesia'. Journal of Abnormal and Social Psychology, 1962, 65, 411-418.

Blitz, B. and Dinnerstein, A. J. Effects of different types of instructions on pain parameters. Journal of Abnormal Psychology, 1968, 73, 276-280.

Blitz, B. and Dinnerstein, A. J. Role of attentional focus in pain perception: Manipulation of response to noxious stimulation by instructions. Journal of Abnormal Psychology, 1971, 77, 42-45.

Bowers, K. S. Pain, anxiety and perceived control. Journal of Consulting and Clinical Psychology, 1968, 32, 596-602.

Brown, R. A., Fader, K., and Barber, T. X. Responsiveness to pain: Stimulus-specificity versus generality. Psychological Record, 1973, 23, 1-7.

Champion, R. A. Studies of experimentally induced disturbance. Australian Journal of Psychology, 1950, 2, 90-99.

Chaves, J. F. and Barber, T. X. Cognitive strategies, experimenter modeling, and expectation in the attenuation of pain. Journal of Abnormal Psychology, 1974, 83(4), 356-363.

Clark, J. and Bindra, D. Individual differences in pain thresholds. Canadian Journal of Psychology, 1956, 10, 69-76.

Corah, H. L. and Boffa, J. Perceived control, self observation, and response to aversive stimulation. Journal of Personality and Social Psychology, 1970, 16, 1-4.

Davidson, P. O. and McDougall, C. E. A. The generality of pain tolerance. Journal of Psychosomatic Research, 1969, 13, 83-89.

Davison, G. C. and Valins, S. Maintenance of self attributed and drug attributed behaviour change. Journal of Personality and Social Psychology, 1969, 11, 25-33.

Evans, M. B. and Paul, G. L. Effects of hypnotically suggested analgesia on physiological and subjective responses to cold stress. Journal of Consulting and Clinical Psychology, 1970, 35, 362-371.

Gardner, W. J., Licklider, J. C. R., and Weisz, A. Z. Suppression of pain by sound. Science, 1960, 132, 32.

Gelfand, S. The relationship of experimental pain tolerance to pain threshold. Canadian Journal of Psychology, 1964, 18, 36-42.

Glass, D. C., Singer, J. E., and Friedman, L. N. Psychic cost of adaptation to an environmental stressor. Journal of Personality and Social Psychology, 1969, 12, 200-210.

Hall, K. R. L. and Stride, E. The varying response to pain in psychiatric disorders: A study in abnormal psychology. British Journal of Medical Psychology, 1954, 27, 48-60.

Haslam, D. R. The effect of threatened shock on pain threshold. Psychonomic Science, 1966, 6, 309-310.

Hilgard, E. R. Pain as a puzzle for psychology and physiology. American Psychologist, 1969, 24, 103-113.

Johnson, R. F. Q. Suggestions for pain reduction and response to cold induced pain. Psychological Record, 1974, 24, 161-171.

Kanfer, F. H. and Goldfoot, D. A. Self-control and tolerance of noxious stimulation. Psychological Reports, 1966, 18, 79-85.

Kosambi, D. D. Living prehistory in India. Scientific American, 1967, 216, 105.

Lambert, W. E., Libman, E., and Poser, E. G. The effects of increased salience of a membership group on pain tolerance. Journal of Personality, 1960, 28, 350-357.

Lepanto, R., Moroney, W., and Zenhausern, R. The contribution of anxiety to the laboratory investigation of pain. Psychonomic Science, 1965, 3, 475.

Liebeskind, J. C. and Paul, L. A. Psychological and physiological mechanisms of pain. Annual Review of Psychology, 1977, 28, 41-61.

Melzack, R. The Puzzle of Pain. England: Penguin, 1973.

Mersky, J. The perception and measurement of pain. Journal of Psychosomatic Research, 1973, 17, 251-255.

Nisbett, R. E. and Schachter, S. Cognitive manipulation of pain. Journal of Experimental Social Psychology, 1966, 2, 227-236.

Notermans, S. L. H. and Tophoff, M. M. W. A. Sex difference in pain tolerance and pain apperception. In M. Weisenberg (Ed.), Pain: Clinical and experimental perspectives. Saint Louis: C. V. Mosby, 1975.

Orne, M. T. On the social psychology of the psychological experiment with particular reference to demand characteristics and their implications. American Psychologist, 1962, 17, 776-783.

Rosenthal, R. On the social psychology of the psychological experiment: The experimenter's hypothesis as unintended determinant of experimental results. American Scientist, 1963, 51, 268-283.

Schludermann, E. and Zubek, J. P. Effect of age on pain sensitivity. Perceptual Motor Skills, 1962, 14, 295-301.

Scott, D. S. and Barber, T. X. Cognitive control of pain: Four serendipitous results. Perceptual and Motor Skills, 1977, 44(2), 569-570.

Spanos, N. P., Barber, T. X., and Lang, G. Cognition and self control: Cognitive control of painful sensory input. In H. London and R. E. Nisbett (Eds.), Thought and Feeling: Cognitive alteration of feeling states. Chicago: Aldine, 1974.

Spanos, N. P., Horton, C., and Chaves, J. F. The effects of two cognitive strategies on pain threshold. Journal of Abnormal Psychology, 1975, 84(6), 677-681.

Tursky, B. and Sternbach, R. A. Further physiological correlates of ethnic differences in responses to shock. Psychophysiology, 1967, 4, 67-74.

Wolff, B. B. The relationship of experimental pain tolerance to pain threshold: A critique of Gelfand's paper. Canadian Journal of Psychology, 1964, 18, 249-253.

Wolff, B. B. Behavioural measurement of human pain. In R. A. Sternbach (Ed.), The Psychology of Pain, New York: Raven Press, 1978.

Wolff, B. B. and Horland, A. A. Effect of suggestion upon experimental pain: A validation study. Journal of Abnormal Psychology, 1967, 72, 402-407.

Wolff, B. B. and Jarvik, M. E. Variations in cutaneous and deep somatic pain sensitivity. Canadian Journal of Psychology, 1963, 17, 37-44.

Wolff, B. B. and Jarvik, M. E. Relationship between superficial and deep somatic thresholds of pain with a note on handedness. American Journal of Psychology, 1964, 77, 589-599.

Wolff, B. B., Krasnegor, N. A., and Farr, R. S. The effect of suggestion upon experimental pain response parameters. Perceptual and Motor Skills, 1965, 21, 675-683.

Woodrow, K. M., Friedman, G. D., Siegelaub, A. B., and Collen, M. F. Pain tolerance differences according to age, sex, and race. Psychosomatic Medicine, 1972, 34, 548-556.

Zborowski, M. Cultural components in responses to pain. Journal of Social Issues, 1952, 8, 16.

Zimbardo, P. G., Cohen, A. R., Weisenberg, M., Dworkin, L., and Firestone, I. Control of pain motivation by cognitive dissonance. Science, 1966, 151, 217-219.